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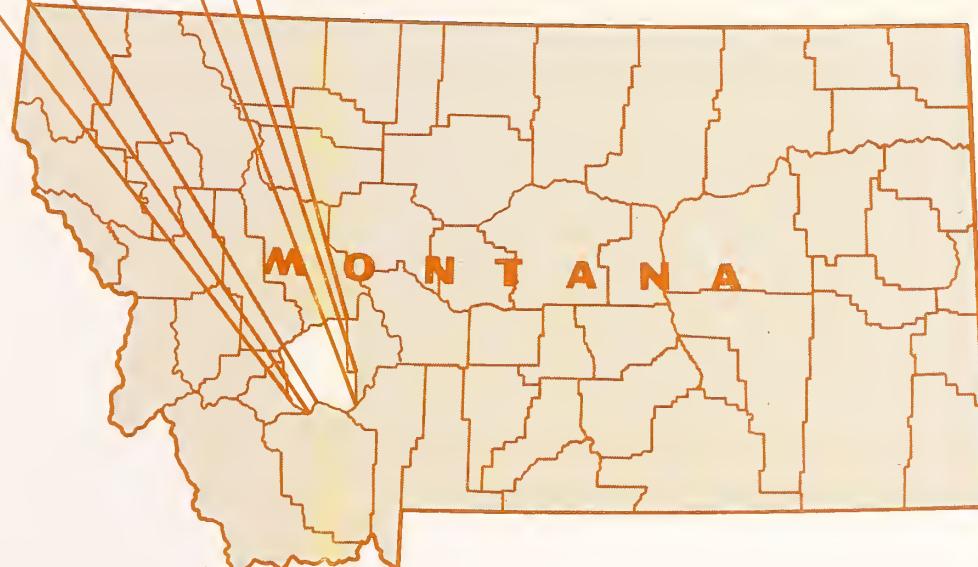
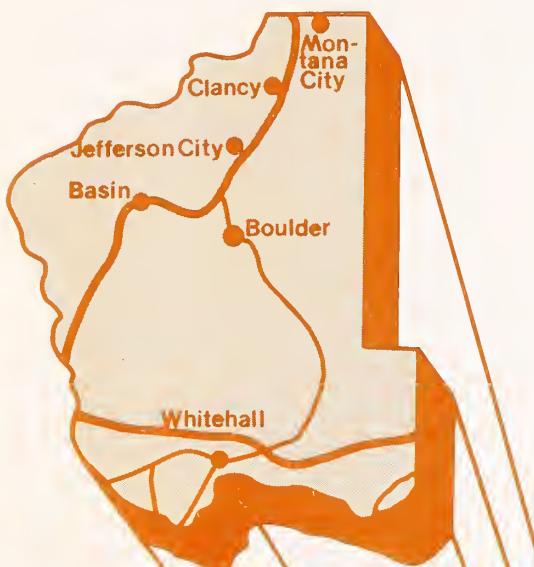
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HIGH HAZARD LOCATION STUDY

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ROBERT PECCIA & ASSOCIATES
Planners - Engineers - Designers
P.O. BOX 4518 810 HIALEAH COURT
HELENA, MONTANA 59604 406/442-8160

February 25, 1983

Board of County Commissioners
Jefferson County
Boulder, Montana 59632

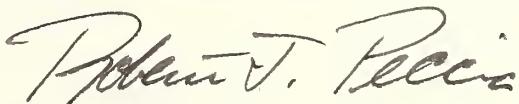
Transmitted herewith is the final report for the Jefferson County High Hazard Location Study. This report documents the results of the traffic studies and surveys performed in the evaluation of nine locations in Jefferson County.

Included in this report are: 1) a thorough assessment of the existing conditions at each site; 2) an accident analysis of all reported accidents at each site during the four-year period from January, 1978 through December, 1981; 3) a short-term, low-cost improvement program complete with a prioritized project list based on the relative hazardousness of each site; and 4) a series of long-term, more expensive solutions, generally involving road reconstruction.

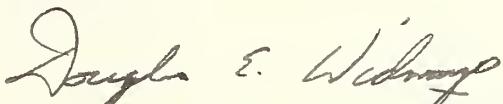
It has been a pleasure working with you, and we appreciate your guidance throughout the project. We hope you are satisfied with this report and find it useful in reducing traffic hazards in Jefferson County. If you have any questions or are in need of additional information, please don't hesitate to contact us.

Respectfully submitted,

ROBERT PECCIA & ASSOCIATES

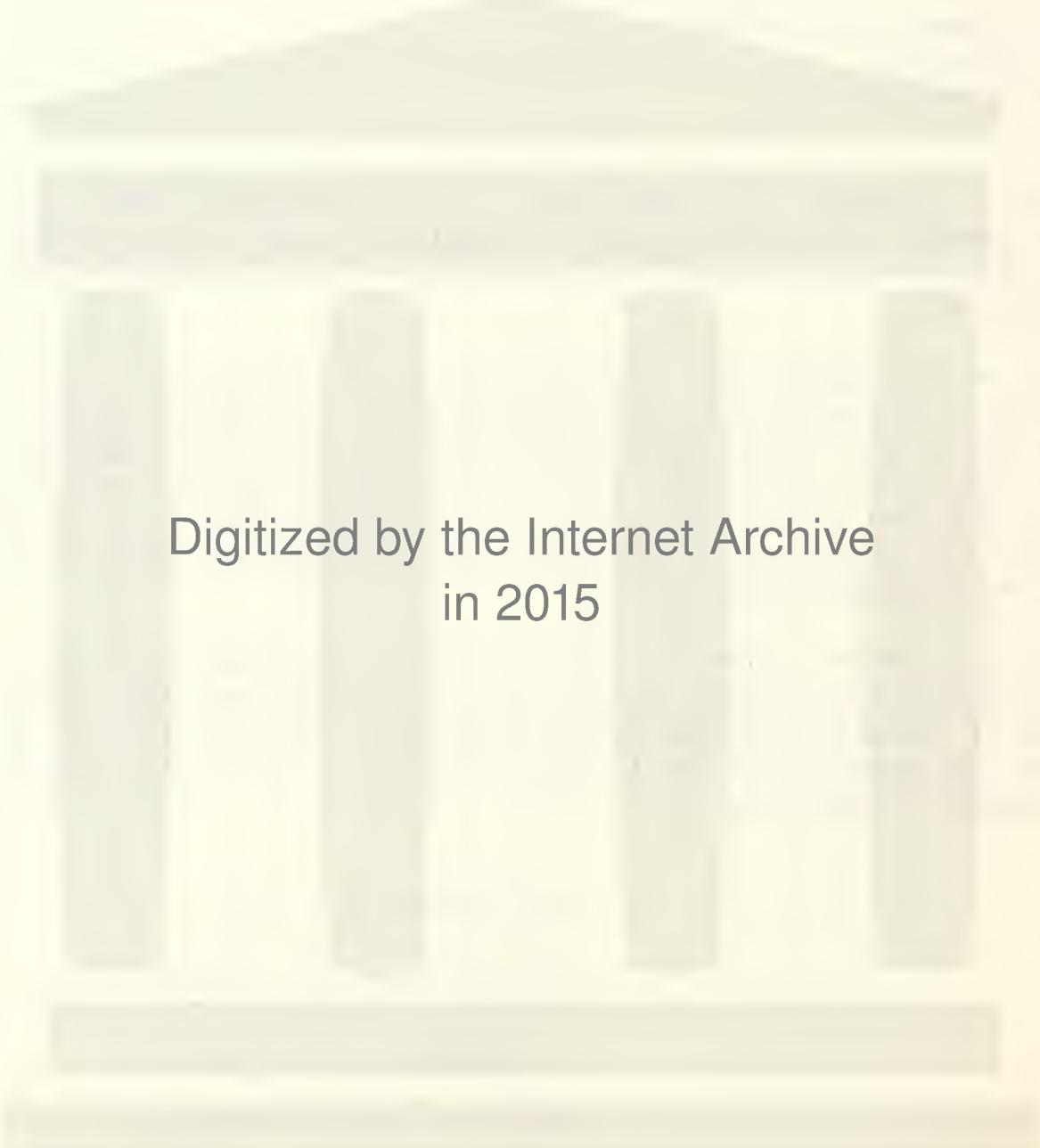


Robert J. Peccia, President



Douglas Widmayer, Project Engineer

DW/gp



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JEFFERSON COUNTY HIGH HAZARD LOCATION STUDY

Prepared For:

Jefferson County, Montana

In Cooperation With:

State of Montana Department of Justice

Highway Traffic Safety Division

and

the Montana Association of Counties

Prepared By:

Robert Peccia & Associates, Inc.

Helena, Montana

January, 1983

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- Figure D Recommended Improvements

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Photo plates are included for each site in their appropriate sections.

CHAPTER I

INTRODUCTION

CHAPTER I

INTRODUCTION

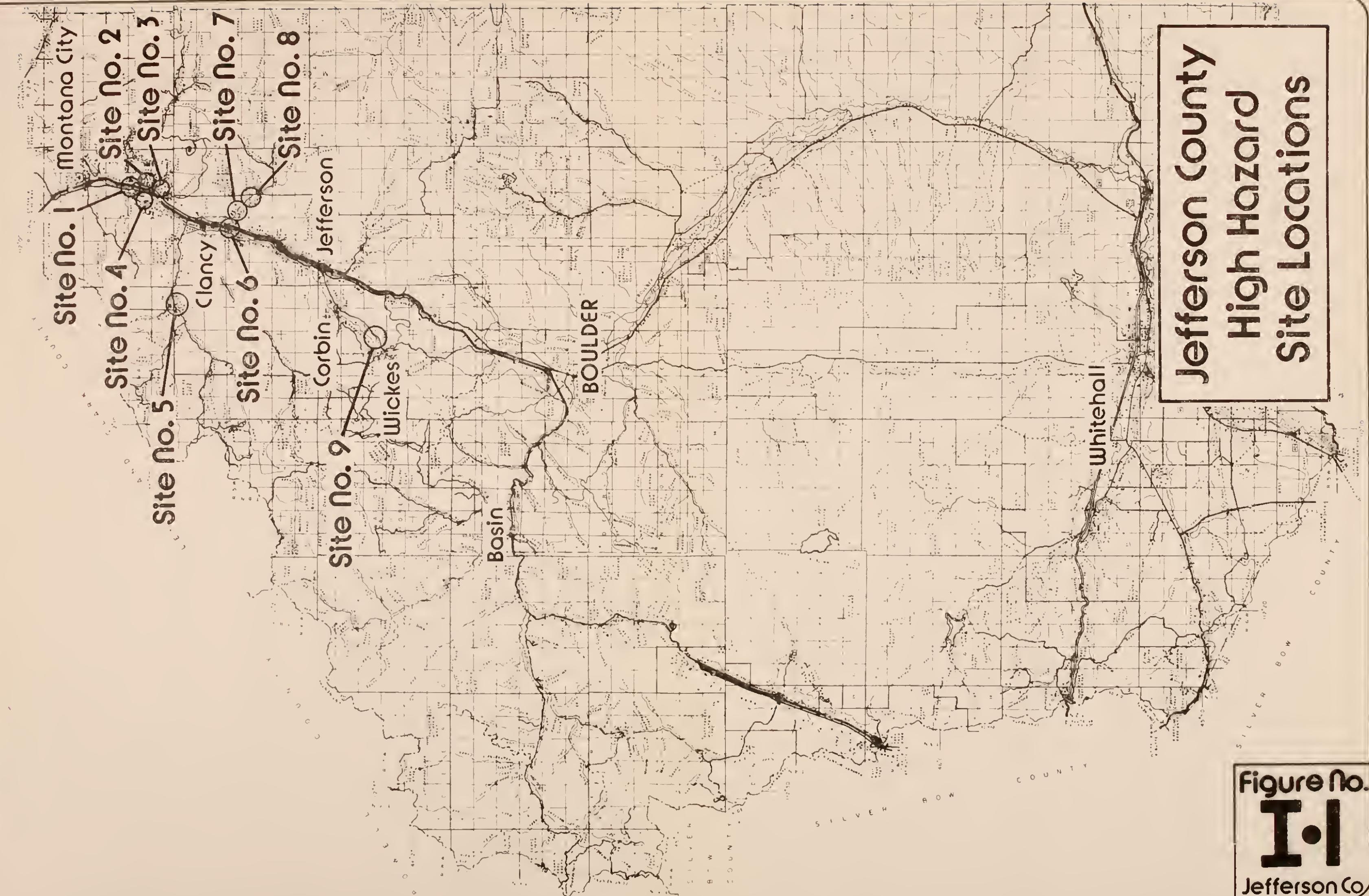
The purpose of this report is to evaluate nine hazardous road locations in Jefferson County and to recommend appropriate improvements. The sites were chosen by Jefferson County with the assistance of the Department of Justice, Highway Traffic Safety Division, based on accident history and roadway characteristics. The sites are referenced in Table 1 below and shown on a location map, Figure I-1.

The analysis contained within this report is based on procedures outlined in Report No. FHWA-RD-77-83, Identification of Hazardous Locations, as refined by DCA Project No. 79-04-01-01, Preliminary Evaluation Program for High Hazard Location Study, Yellowstone County, Montana.

Short-term and in some cases long-term improvements that would reduce or eliminate hazardous conditions have been included for each site. Emphasis was given to relatively low-cost improvements in an effort to present solutions within the funding capabilities of the County. A priority ranking of site improvement projects was developed based on a composite hazard ranking and benefit/cost ratios.

TABLE NO. 1
LIST OF SITES

Site #1:	I-15 Frontage Road at the Underpass between Montana City and Clancy
Site #2:	Intersection of Frontage Road and Main Entrance to Gruber Estates
Site #3:	Intersection of Frontage Road and South Entrance to Gruber Estates
Site #4:	Blue Sky Heights Road at Prickly Pear Creek Bridge
Site #5:	Lump Gulch Road
Site #6:	Intersection of Frontage Road and Warm Springs Creek Road
Site #7:	Warm Springs Creek Road at Rattlesnake Creek Area
Site #8:	Warm Springs Creek Road at Badger Creek Area
Site #9:	Wickes - Corbin Road (1.2 miles northeast of Wickes)



CHAPTER II

SUMMARY & RECOMMENDATIONS

CHAPTER II

SUMMARY AND RECOMMENDATIONS

A. Summary

The purpose of this study is to identify the factors contributing to unsafe traffic conditions at nine hazardous locations selected by Jefferson County, and to recommend improvements that would remedy the unsafe conditions. At each location, a field inspection was made, the site geometrics were recorded, site condition sketches were made, and manual and machine traffic counts were taken. In addition, the accident records for the last four years were obtained from the Department of Justice and analyzed.

Solutions to the problems that were identified included short-term low-cost traffic management-type improvements, and long-term more permanent solutions generally involving road reconstruction and higher costs. These recommended improvement costs are summarized in Table 2.

The nine hazardous sites selected by Jefferson County had 35 accidents reported during the four-year period from 1978 through 1981. These accidents included 12 injury and 23 property damage accidents. There were no fatalities reported during the study period. The annual cost of these accidents, according to National Safety Council figures, is \$94,410. Based on the average accident reduction figures established by the Department of Highways, the short-term improvements recommended in this report could eliminate 50 percent of these accidents.

B. Short-Term Improvements

The short-term improvements recommended for each site concentrate on supplying better guidance to the motorist through conventional signing and striping methods and on improving sight distance within existing right-of-way limits. The average short-term improvement cost for each site is \$1,583. The total cost of all short-term improvements is \$14,243, based on current construction costs.

C. Long-Term Improvements

Long-term improvements were recommended where deficiencies at a site could not be completely corrected by short-term, low-cost improvements. The long-term improvements generally consist of minor road reconstruction. Due to the nature and the time frame involved with these long-term improvements, it is recommended that they be implemented as funds become available. The total cost of all the long-term improvements is \$167,020, based on 1982 construction costs.

TABLE NO. 2
 SHORT- & LONG-TERM IMPROVEMENT COSTS

Site No.	Site Name	Short-Term Improvement Cost	Long-Term Improvement Cost
1.	I-15 Frontage at Underpass	\$2,408	\$ 3,770
2.	Main Entrance to Gruber Estates	679	3,600
3.	South Entrance to Gruber Estates	651	7,500
4.	Blue Sky Heights Road & Prickly Pear Creek Bridge	3,215	95,000
5.	Lump Gulch Road	1,192	16,000
6.	Frontage Road and Warm Springs Creek Road	1,604	10,150
7.	Warm Springs Creek Road at Rattlesnake Creek	1,628	15,000
8.	Warm Springs Creek Road at Badger Creek	1,416	16,000
9.	Wickes - Corbin Road	<u>1,450</u>	<u>*</u>
Total Cost:		\$14,243	\$167,020

* At Site #9, the short-term improvements adequately addressed the problems at this location; therefore, no long-term improvements were recommended.

D. Prioritization

To aid the County in deciding the order of implementation for the short-term improvements, a Priority Ranking has been provided. This ranking evaluates the relative hazardousness of each site and the cost of the short-term improvements.

To evaluate the relative hazardousness of each site, a Hazard Index was calculated. This Hazard Index is based on three accident indicators (number of accidents, accident severity, and accident rate) and four "non-accident" indicators (volume/capacity ratio, sight distance ratio, driver expectancy, and information system deficiency). Each site has been ranked according to the accident and non-accident indicators, and the Hazard Index is shown in Table 3.

To determine the proper order of implementation for the short-term improvements, the cost of the improvement must be evaluated with respect to the average traffic volume and the site's Hazard Index. Cost factors and benefit/cost ratios were calculated for each site improvement, and are shown in Table 4.

A Priority Index, which is a weighted average of the Hazard Index and the Cost Factor, was computed for each site. The Priority Index ranking is the recommended order of implementation and should be used as the major consideration in selecting the order of funding for these sites. Due to possible funding limitations, it may be advantageous to skip one or two improvement projects in order to implement a greater number of improvements. The Priority Index ranking of the short-term improvements is shown in Table 5.

No prioritization has been offered for the long-term improvements due to the costs involved. It is recommended that the long-term improvements be implemented as funds and/or right-of-way become available.

E. Implementation

The short-term improvements recommended in this report address the major problems at each site. After evaluating the availability of funds, Jefferson County should schedule the implementation of the short-term improvement projects according to the priority listing shown in Table 5. Due to the relatively low cost of these improvements, it is believed that implementation could be scheduled over a two- to three-year period without becoming a financial burden on the County. It is recommended to complete the short-term improvement program prior to funding any of the long-term improvements.

All long-term improvements are considered of equal importance and should be implemented as funds become available.

Throughout this report, when warning signs are recommended, the 30" x 30" size sign is to be used. Likewise, all advisory speed plates should be of the 18" x 18" size. The placement of all signs, delineators, guard rails, and pavement markings should always be in conformance with the Manual on Uniform Traffic Control Devices.

TABLE NO. 3
 HAZARD INDEX RANKING

Ranking	Site No.	"Accident" Indicators	Ranking	Site No.	"Non-Accident" Indicators
1	7	42.32	1	5	34.88
2	8	42.23	2	7	34.43
3	9	41.94	3	8	34.20
4	5	41.85	4	4	33.28
5	4	36.28	5	1	28.09
6	6	30.59	6	3	26.86
7	1	30.37	7	9	22.19
8	2	29.27	8	6	21.59
9	3	21.23	9	2	12.26

Ranking	Site No.	Hazard Index
1	7	76.75
2	5	76.73
3	8	76.43
4	4	69.56
5	9	64.13
6	1	58.46
7	6	52.18
8	3	48.09
9	2	41.53

TABLE NO. 4
 BENEFIT/COST RANKING

Ranking	Site No.	Short-Term Improvement Cost	Cost Factor Indicator	Benefit/Cost Ratio
1	5	\$1,192	93	3.3
2	1	\$2,408	97	2.3
3	9	\$1,450	83	2.3
4	6	\$1,604	96	1.6
5	2	\$679	98	1.4
6	8	\$1,416	93	1.4
7	4	\$3,215	94	1.3
8	3	\$651	98	1.3
9	7	\$1,628	92	1.3

TABLE NO. 5

PRIORITY RANKING OF SHORT-TERM IMPROVEMENTS

Priority Ranking	Site No.	Site Name	Short-Term Improvement Cost	Priority Index
1	5	Lump Gulch Road	\$1,192	80.80
2	8	Warm Springs Creek Road at Badger Creek	1,416	80.57
3	7	Warm Springs Creek Road at Rattlesnake Creek	1,628	80.56
4	4	Blue Sky Heights Road and Prickly Pear Creek Bridge	3,215	75.67
5	9	Wickes - Corbin Road	1,450	68.60
6	1	I-15 Frontage Road at Underpass	2,408	68.10
7	6	Frontage Road and Warm Springs Creek Road	1,604	63.14
8	3	South Entrance to Gruber Estates	651	60.57
9	2	Main Entrance to Gruber Estates	679	55.56

CHAPTER III

PROCEDURE & METHODOLOGY

CHAPTER III

PROCEDURE AND METHODOLOGY

A. Field Investigation and Data Collection:

The conclusions and recommendations contained in this report are the product of an extensive data gathering procedure undertaken for each high hazard location. It is impossible to obtain a realistic view of conditions at a particular site without firsthand experience at the site. The background data collected during initial research and on-site visits revealed the circumstances that make one particular location more hazardous than another. The data gathering procedure used during this study included (in chronological order): 1) initial accident research; 2) initial site visit and site identification; 3) site survey; 4) site photography; 5) detailed site sketch; 6) traffic counts; 7) on-site accident analysis; 8) ball bank testing; 9) sight distance determination; 10) subjective rating of site drivability and physical layout; and 11) observation of driver characteristics and quality of travel. The following section contains a brief explanation of each activity undertaken by two field technicians during the data collection stage of this project.

1. Initial Accident Research

The Montana Department of Justice, Highway Traffic Safety Division initially identified accident clusters for individual counties from historical accident reports and accident location plot maps. The accidents within a particular area were then summarized in a list and submitted to Robert Peccia & Associates. All accidents listed were then retrieved and copied from microfilmed records of accident reports. The accident reports were grouped by general location and listed in chronological order. Accidents that occurred during the study period (January, 1978 to December, 1981) were used for further analysis. Those accidents that occurred before or after the study period were retained for reference.

2. Initial Site Visit and Site Identification

The initial visit to each cluster area was made with a representative of each county, if possible, and a representative of the Montana Department of Justice. At this time, the specific high hazard location was identified through the analysis of each group of accident reports and through the input of the local representative. The firsthand knowledge of the long-term accident history and traffic characteristics at each site thus obtained was extremely beneficial.

3. Site Survey

Field technicians utilized survey equipment to identify the physical layout of the roadway itself. Data gathered during the site survey included av-

verage road grades within the site, roadway alignment, superelevation in curves, roadway widths, and identification of right-of-way widths.

4. Site Photography

During site visits, many photographs were taken to illustrate site characteristics or to identify deficiencies within the site. These photographs were utilized in many ways during the preparation of the report and the report graphics. Aerial photography at the largest scale possible was obtained and used during base map preparation and site analysis. In most instances, the combination of aerial photography and extensive "on the ground" photography minimized the need for return visits to the sites.

5. Site Sketch

Sites were stationed at 100-foot intervals and the locations of significant features were mapped. This phase of the data collection involved extensive field measurements of site details including site locations, pavement marking changes, roadside delineators, utilities adjacent to the roadway, fencing, and roadside vegetation. Site photography was also extensively utilized to produce accurate sketches.

6. Traffic Counts

Available traffic count data was obtained from the Planning and Research Bureau of the Montana Department of Highways and used for as many sites as possible. For those sites lacking such information, 24-hour recording traffic counters set to record traffic volumes in 15-minute intervals were set at the required locations. If the site included a major intersection and traffic was significant, peak hour turning movements were conducted in addition to 24-hour traffic counts. This traffic data was used to determine the average daily traffic (ADT) and for capacity analysis. Traffic counts conducted by Robert Peccia & Associates were submitted to the Department of Highways to augment their traffic count data.

7. Accident Analysis

All reported accidents for each specific site location that occurred during the study period of 1/78 through 12/81 were plotted on collision diagrams. Accident data for the study period was also summarized and used in the field. These summaries allowed the field technicians to reconstruct the accidents and to better understand the circumstances that made for unsafe driving conditions at a particular site. The number of accidents and traffic volumes were used to compare accident rates of specific sites.

It should be noted that alcohol-related accidents have been categorized in two ways on the accident data summary sheet contained in each site analysis. In the first instance, alcohol was listed as a possible violation by the driver of the vehicle (i.e., driving while intoxicated.) In this item, alcohol was treated in the same manner as reckless driving, speeding, and other driving violations. In addition, an accident tally was completed that summarized the number of times drinking was listed as a possible violation and identified the number of accidents that had some form of alcohol involvement by the driver or passengers.

8. Ball Bank Testing

The vehicle utilized during field data collection was equipped with a ball bank indicator or safe curve speed indicator. The instrument provides a simple way to establish the safe advisable speed necessary to comfortably pass through a curve where no speed restrictions exist. The posted advisory speeds on curves were also verified through the use of this instrument. Only those sites with unrestricted traffic flows were tested.

9. Stopping Sight Distance Determination

Sight distance is a major element in the safe and efficient operation of any roadway. Stopping sight distance, the minimum distance needed for a vehicle travelling near or at the design speed for the roadway to stop for an object in its path, was measured by two field technicians. Actual sight distance limitations were measured using an eye height of 3.75 feet and an object height of 0.5 feet. Vehicle speed, roadway surface conditions, obstructions, and driver characteristics were also considered in sight distance measurement. The measurement of sight distance at intersections required the development of a minimum sight triangle, which considers unobstructed sight distance along both roads at an intersection and across the included corner.

10. Subjective Rating of Site Drivability and Physical Layout

After the field data was gathered for each site, two field technicians independently rated the drivability of the site and the completeness of the information system presented to motorists entering the site. The rating was completed on the Driver Expectancy and Information System Deficiencies forms, which are discussed in the following section of this chapter. These ratings present a relatively unbiased impression of the site layout and characteristics, since they were arrived at independently by technicians who were not familiar with the site prior to the data collection phase of the project.

11. Observation of Driver Characteristics and Quality of Travel

During the collection of field data, time was taken to observe motorists' driving habits through each site. Field observations of drivers were completed both during day and nighttime light conditions to obtain an overall impression of driver tendencies and to detect deficiencies in the overall layout of the site.

B. Analysis of Data and Calculation of Hazard Indices:

A hazard index was calculated for each site based on the following seven indicator values:

1. Number of Accidents
2. Accident Rate
3. Accident Severity
4. Volume/Capacity Ratio
5. Sight Distance
6. Driver Expectancy
7. Information System Deficiencies

For each indicator, a value between 0 and 100 was calculated, with 0 representing no hazard and 100 representing the most hazardous. The indicator values were then weighted and totalled according to accepted Department of Justice methods and values outlined in DCA Project No. 79-04-01-01 to yield the Hazard Index.

The improvement costs for each site were calculated using current construction costs and weighted against the accident reduction benefits associated with the type of improvement. In addition to the cost/benefit ratio, a cost factor was determined. The cost factor represents the improvement costs per vehicle computed by dividing the total cost for improvements at a site by the number of vehicles entering that location over a period of five years. A five-year period is used because that is the average service life of the recommended short-term improvements. The form used to compute the cost factor is shown in Figure A2 in the Appendix.

The final phase in the analysis was to determine the Priority Index (P.I.). The Priority Index is the weighted average of the Hazard Index (H.I.) and the Cost Factor (C.F.), as shown in the following equation:

$$P.I. = 0.75 (H.I.) + 0.25 (C.F.)$$

The site improvements were then ranked according to priority based on the Accident Hazard Indicators, Non-Accident Hazard Indicators, Cost/Benefit Ratios, Hazard Index, and Priority Index.

The following section contains a brief explanation of each of the Hazard Indicators and the Cost/Benefit Ratio.

1. Number of Accidents

Accident records for a three-year period from January, 1978 through December, 1981 were obtained from the Montana Highway Patrol. This accident data was then used to determine the three "accident" indicators (number of accidents, accident rate and accident severity). The annual average number of accidents occurring at each site was used to calculate this indicator value. Figure A3 in the Appendix shows the relationship between the annual number of accidents and the indicator value.

2. Accident Rate

This indicator is used to compensate for the wide range of traffic volumes found throughout the study sites. The average daily traffic entering each site was calculated and adjusted to represent a three-year volume. The total number of accidents per million vehicles entering the site was then calculated, resulting in the accident rate. This figure was entered into Figure A4 in the Appendix to yield the corresponding indicator value.

3. Accident Severity

This indicator evaluates the severity of the accidents occurring at each site in terms of dollars. A "Relative Severity Index" (Table A1 of the Appendix) was used to rate each accident according to accident type and to assign a corresponding accident cost. The R.S.I. values used are those in-

cluded in DCA Project No. 79-04-01-01. The average of the R.S.I. values at each site was calculated and entered into Figure A5 in the Appendix to determine the appropriate indicator value.

4. Volume-to-Capacity Ratio

The individual characteristics of the sites vary greatly. This indicator value normalizes each site with respect to lane width, geometrics, traffic mix and volume. The capacity of each site was calculated for Service Level C in accordance with the Highway Research Board, Special Report 87, Highway Capacity Manual. The volume used represents the average daily traffic entering the site. The equation used to compute the index is as follows:

$$\frac{V}{C} = \frac{\text{ADT}}{24 \text{ (Capacity)}}$$

This ratio was entered into Figure A6 (found in the Appendix) to yield the corresponding indicator value.

5. Sight Distance

The sight distance at a particular site is an excellent indicator of the hazardousness of that location. Critical sight distances were measured at each location based on the criteria outlined in the DCA Project No. 79-04-01-01. The desirable sight distances for each particular location were then calculated according to the AASHO Manual Geometric Design of Rural Highways. For each case, the ratio of the existing versus the desirable Sight Distance was calculated. The two worst cases at each site were evaluated and a weighted average was computed by assigning a weight of two to the worst rating and one to the other rating. This weighted average sight distance ratio entered into Figure A7 (found in the Appendix) yields the corresponding indicator value.

6. Driver Expectancy

The driver expectancy indicator is a purely subjective method of evaluating the ability of the average motorist to negotiate a particular section of roadway or intersection. Each site approach was rated using the criteria included on the driver expectancy form shown on Figure A8 in the Appendix. Each site was evaluated individually by two technicians and the ratings were averaged. The two approaches with the worst ratings were used in the calculation of the indicator value. A weighted average of the two ratings was calculated according to DCA weighting methods and used in Figure A9 of the Appendix to compute the corresponding indicator value.

7. Information System Deficiencies

Similar to the driver expectancy ratings, this indicator is based on the subjective judgment of the evaluator. This rating consists of evaluating the signing and striping systems at each site with respect to the systems' ability to inform and guide the motorist through a particular section of road or in-

tersection. The actual criteria used in this evaluation are shown on the rating form (Figure A10) found in the Appendix.

All site approaches were independently rated by two technicians and their ratings averaged. Only the two worst average approach ratings were actually used to calculate this indicator. A weighted average of the two ratings was computed according to the weighting formula outlined in DCA Project 79-04-01-01. This weighted average was entered into Figure A11 in the Appendix to yield the appropriate indicator value.

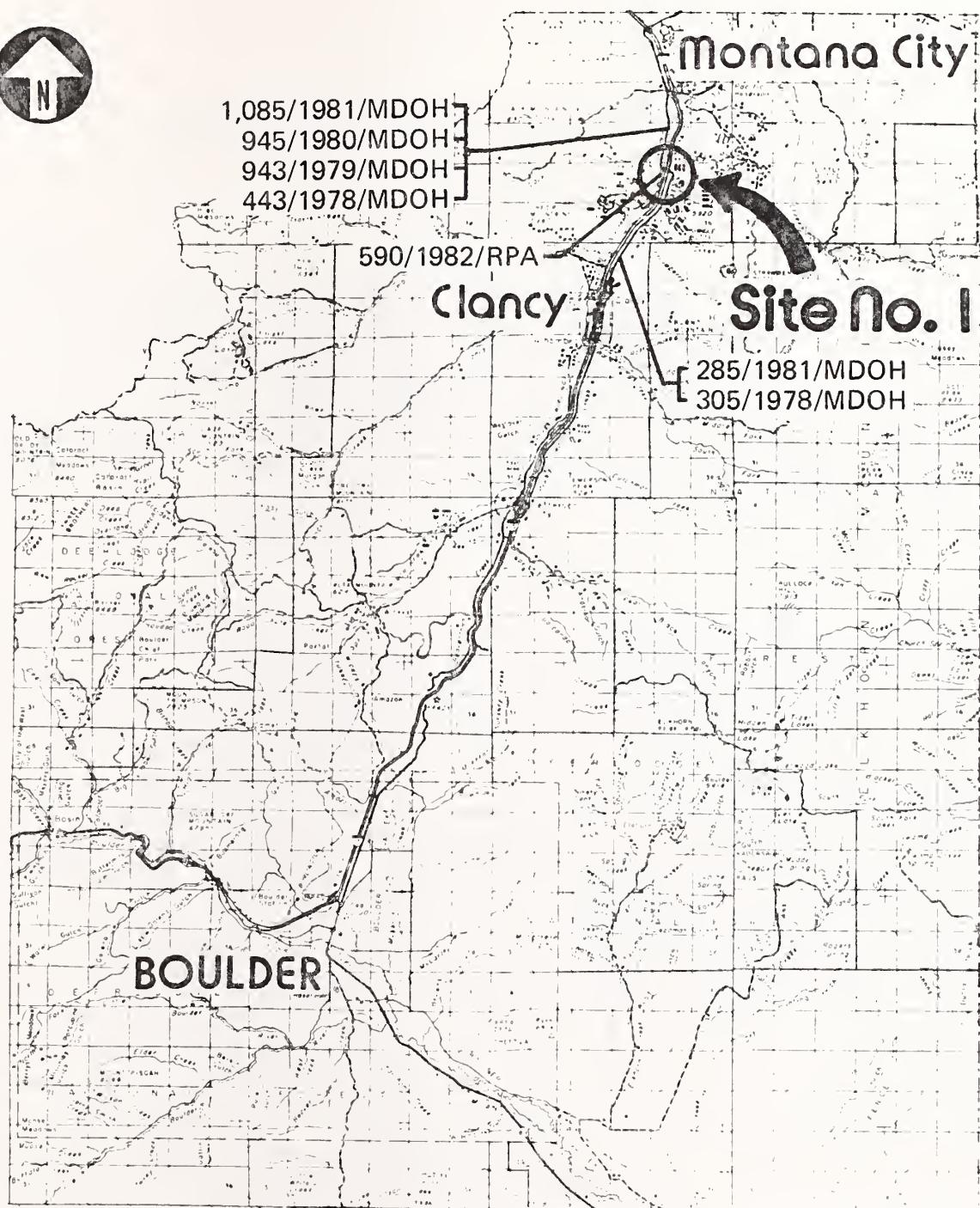
8. Benefit/Cost Ratio

Each site was analyzed and improvements were recommended. The improvement costs were estimated based on current Department of Highways statewide average construction costs. Although it is likely that Jefferson County will implement some of the improvements with County forces, the "contracted" construction costs were used throughout for comparison purposes.

The benefits of each improvement were calculated based on the anticipated accident reduction resulting from that particular improvement. The Montana Department of Highways method for calculating the benefit/cost ratio was used and the computation format is shown in Figure A12 of the Appendix. A ranking of each site based on the benefit/cost ratio was compiled and is presented in Table 4. The site improvement yielding the greatest accident reduction benefit per dollar spent was given the highest ranking.

CHAPTER IV

SITE ANALYSIS



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
INTERSTATE 15 UNDERPASS

Figure No.
I-A
Jefferson Co

SITE #1

I-15 FRONTAGE ROAD AT UNDERPASS

A. Location

Site #1 is located on the I-15 Frontage Road approximately 2.0 miles south of the interchange at Montana City. The site consists of the intersection of the I-15 Frontage Road with the Blue Sky Heights Road, the I-15 underpass, and a curve on each approach to the site. The roadway is heavily used by residents of nearby rural subdivisions who commute daily to and from jobs in Helena. Land in the area near this site is primarily used for residential purposes. The location of Site #1 and the available traffic count data are presented in Figure 1A.

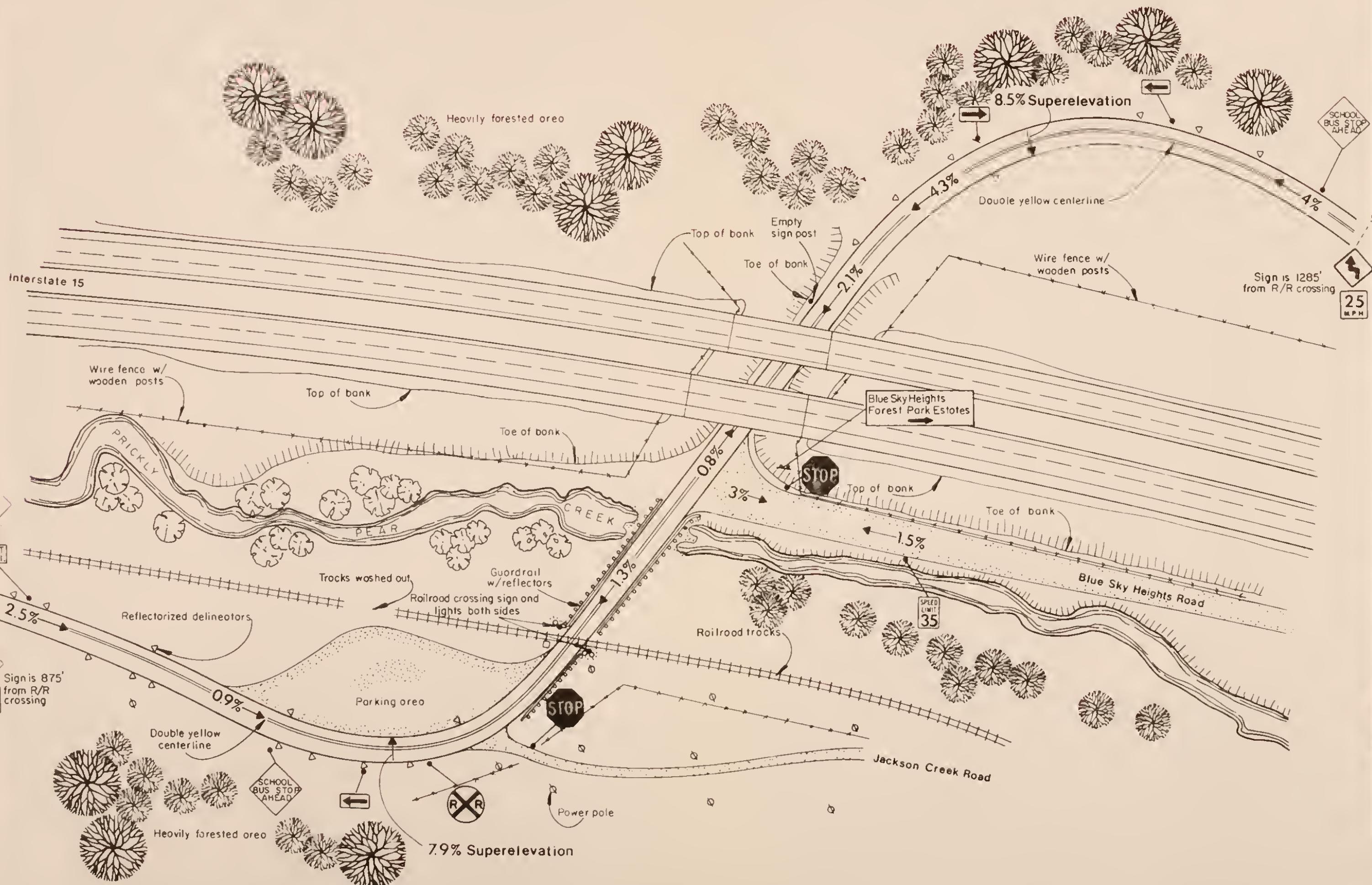
B. Existing Conditions

The I-15 Frontage Road at Site #1 has an asphalt surface that is typically 24 feet wide. A double yellow centerline divides the roadway into two 12-foot driving lanes. Road grades within the northern half of the site range from 1.0 to 2.5 percent. Grades in the southern half of the site are somewhat steeper, ranging from 2.1 to 4.3 percent. The superelevation in the broad curves on each approach is approximately 8 percent. The Blue Sky Heights Road, which parallels the interstate at this location, intersects the Frontage Road with a general grade of 3 percent. Blue Sky Heights Road is a 28-foot-wide gravel-surfaced roadway in the vicinity of this intersection. Sight distance is limited in the curve on the south approach and at the intersection of the Frontage Road with the Blue Sky Heights Road. Sight distance at this intersection is limited to approximately 100 feet by the I-15 underpass and adjacent embankments.

Signing on the north approach to the underpass consists of a "School Bus Stop Ahead" sign (S3-1) located 500 feet north of the Blue Sky Heights intersection; a large arrow directional signs (W1-6) located in the curve; a railroad advance warning sign (W10-1) located about 175 feet north of the railroad crossing; and railroad crossing (crossbuck) signs (R15-1) signs with flashing signals. It should be noted that the railroad tracks near the site were severely damaged during the Prickly Pear Creek flood of 1981 and have not been repaired. As a result, the post-mounted flashing signals are not utilized. Signing on the south approach to the underpass consists of a "School Bus Stop Ahead" sign (S3-1) located approximately 700 feet south of the Blue Sky Heights intersection; a large directional arrow (W1-6) located in the curve and intended for northbound drivers; and a similar directional arrow sign intended for southbound motorists. Reverse turn signs (W1-3) with 25 mph advisory speed plates are located approximately 500 feet before the turn in both approaches to the site. The two intersecting roads at this site, the Blue Sky Heights Road and Jackson Creek Road, have stop signs

EXISTING CONDITIONS

Scale in Feet



FRONTAGE ROAD AT INTERSTATE 15 UNDERPASS

A vertical decorative element consisting of a stylized floral or foliate motif, rendered in a dark, textured material, possibly wood or stone, with intricate carvings.

Figure No. **I.B** Jefferson Co.

Existing Site Conditions



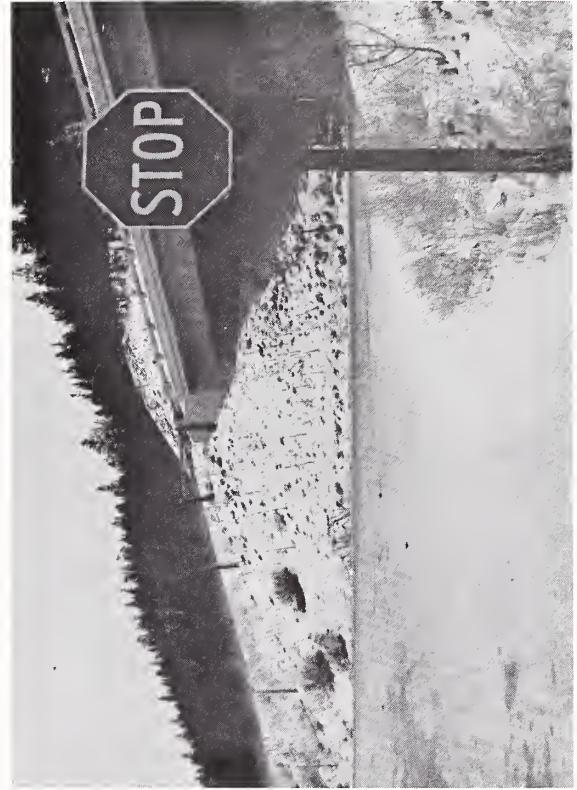
View of signing, striping, and delineation in the curve on the north approach at Site 1.



View of the signing, striping, and delineation in the curve on the south approach to the site.



The Frontage Road near the intersection of Blue Sky Heights Road and the Frontage Road. The BNR line at the site has not been used since it was damaged by flooding in 1981.



View of the intersection of Blue Sky Heights Road and the Frontage Road. Note sight distance limitations caused by the embankment at right.

installed near their intersection with the frontage road. Much of the roadway at this site has reflectorized delineators installed at the roadway edge to guide motorists through the site. Silver bi-directional adjustable reflectors have been installed through the corners on both the north and south approaches to the site. Guard rails have also been installed along the roadway over the Prickly Pear Creek culverts and near the railroad crossing. The guard rail sections on both sides of the road in the area between the railroad crossing and the Blue Sky Heights Road intersection are equipped with amber reflectors to delineate the roadway edge. Existing conditions at Site #1 are depicted in the site sketch (Figure 1B) and in site photographs (Plate 1).

Machine counts of 24-hour traffic volumes were collected at the site by the Montana Department of Highways and Robert Peccia & Associates. Based on this data, average daily traffic (ADT) for the site was determined. Counts of average daily traffic are available for four locations in the area of the site and were used to approximate the ADT for the underpass location. The location of these four count locations and historical traffic count data is presented in Figure 1A. As shown, the average daily traffic on the north approach on the Frontage Road is estimated to be 1,000 vehicles, and the ADT on the Blue Sky Heights Road is estimated to be 590 vehicles.

C. Accident History

A total of five accidents were reported at this site during the four-year study period. Four of the five accidents resulted in injuries to a total of six persons. Three of the five accidents were two-vehicle collisions which included a sideswipe meeting accident, a rear-end collision, and an angle collision. All five accidents reported at this site occurred on the north approach to the underpass. Three accidents occurred in the curve on the north approach and two at the Blue Sky Heights Road intersection. All five occurred during the day, and only one of the five accidents occurred during icy road conditions. Major contributing circumstances to the accidents at this site were listed as reckless driving and excessive speed. Alcohol was not involved in any of the accidents that occurred at this site during the study period. The composite collision diagram for this site is depicted in Figure 1C.

The accident rate at this site is 3.4 accidents per million vehicles entering.

D. Recommendations

Although this site seems to be adequately signed and delineated, accident records indicate that motorists still have problems negotiating this section of road. The short-term improvements listed below concentrate on modifying the present signing to better direct motorists through the site.

1. A vehicle equipped with a ball bank indicator was used to determine that 20 mph is the maximum safe speed for the curves at this site. It is recommended that the existing 25 mph advisory speed plates (W13-1) presently mounted with the reverse turn signs on each approach be removed and replaced with the more appropriate 20 mph advisory plates (W13-1).

COLLISION DIAGRAM



SYMBOLS

 VEHICLE PATH
 PEDESTRIAN PATH
 BACKING VEHICLE
 PARKED VEHICLE
 FIXED OBJECT
 FATAL ACCIDENT
 INJURY ACCIDENT

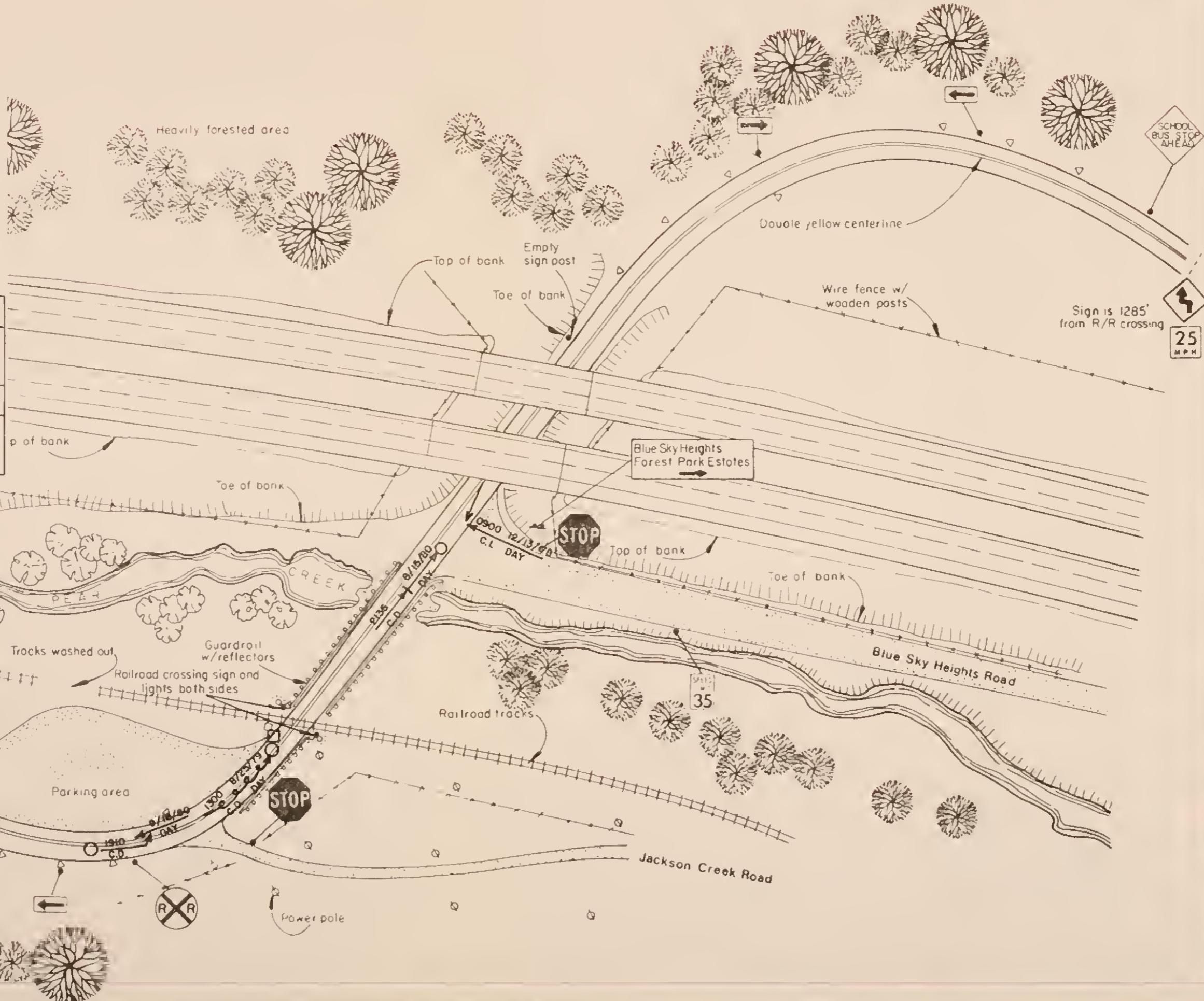
COLLISION TYPES

CONDITIONS

WEATHER:
F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: *D*=Dry *W*=Wet *I*=Icy

TIME 1400 7-05-75 DATE
WEATHER C. D. DAY LIGHT
PAVEMENT



FRONTAGE ROAD AT INTERSTATE 15 UNDERPASS

Figure No. I-C Jefferson Co.

ACCIDENT DATA

I-15 Frontage Road at Underpass

SITE NUMBER 1

ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
1	2	2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
				1	1	1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
							2	2			1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
								1	1	1								1	1				

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
5			

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
4			1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
5			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swi-pe	Non-Coll	Head-on	Backing
1		1	1			1	1		

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
2		1	1					1

NUMBER OF ACCIDENTS BY SEVERITY

Injury Fatality Property Dam. Only	1978	1979	1980	1981
		2	2	
	1			

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

0

2. The intersection of the Blue Sky Heights Road should be adequately signed. It is recommended that a stop ahead sign (W3-1) be installed 500 feet south of the intersection on the Blue Sky Heights Road. A large (24" x 48") double directional arrow (W1-7) should be installed on the north side of this intersection and located so that it is visible from at least 500 feet back on the south approach. Side road warning signs (W2-2) should be placed on both the east and west approaches to the intersection, and should be located 250 feet back from the intersection. As a general rule, these warning signs would be installed 500 feet or more in advance of the intersection, but due to the geometrics of the site, a 250-foot setback distance is more appropriate.

3. Since the railroad tracks were washed out during the 1981 flood, there has been no train traffic through this site. The Burlington Northern Railroad has officially abandoned this section of line and has no future plans for its use. It is therefore recommended that the railroad advance warning sign (W10-1) located on the north approach be removed.

4. In an effort to better guide motorists around the curve on the north approach, a series of seven chevron warning signs (W1-8) should be installed. These chevrons should be located on the outside of the curve and spaced 60 feet apart. The recommended location of these signs is shown in Figure 1D.

5. The existing large directional arrow (W1-6) located on the north approach should be relocated. The chevron signing mentioned above will adequately guide southbound traffic around this curve; the large directional arrow should be installed in the same curve so that it directs northbound traffic. The recommended placement of this sign is shown in Figure 1D. The sign should be visible to approach traffic for at least 500 feet on the curve approach.

6. The location of the school bus stop ahead sign (S3-1) on the north approach conflicts with the recommended chevron signs discussed in item 4. This school bus stop ahead sign should therefore be relocated 200 feet farther north on this approach. At this new location, the sign will still be effective but will not interfere with the chevron signs.

7. The guard rail sections across Prickly Pear Creek are incorrectly delineated by a series of amber reflectors. In this particular situation, the use of amber reflectors is both incorrect and misleading. In general, amber reflectors should only be used to delineate a side road entrance or to delineate the left edge of the roadway. In this case, the amber reflectors are located on the right side of the road for both directions of approach traffic. All of these amber reflectors should be removed, and replaced with a more conventional system of Type 3 object markers (OM-3, 12" x 36"). These object markers should be placed on both ends of the guard rail on the north side of the road and only on the west end of the guard rail on the south side.

The east end of the guard rail on the south side of the road is wrapped around the corner, and requires no delineation.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Remove 25 mph Advisory Speed Plates	\$35	\$ 70
2	ea	Install 20 mph Advisory Speed Plates (W13-1)	\$35	70
1	ea	Install Stop Ahead Warning Sign (W3-1)	\$130	130
1	ea	Install Large Double Directional Arrows (W1-7)	\$163	163
2	ea	Install Side Road Warning Signs (W2-2)	\$130	260
1	ea	Remove Railroad Ahead Warning Signs (W10-1)	\$35	35
7	ea	Install Chevron Warning Signs (W1-8)	\$130	910
1	ea	Relocate Large Directional Arrows (W1-6)	\$70	70
1	ea	Relocate School Bus Stop Ahead Warning Sign (S3-1)	\$70	70
24	ea	Remove Amber Reflectorized Delineators	\$10	240
3	ea	Install Object Markers (OM-3)	\$130	<u>390</u>
Total Cost:				\$2,408

Benefit/Cost Ratio: 2.3

Long-Term Improvements

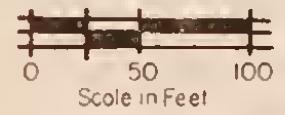
As previously discussed, the section of railroad line passing through this site has been abandoned and is not expected to be brought back into service. It is therefore recommended that the tracks across the road be removed. In addition, all warning signal hardware should be removed. This will serve to eliminate the rough surface of the track crossing as well as simplifying the signing system at this site. The amount of information that drivers have to digest while negotiating this site will be reduced. In addition, the two sections of guard rail on the south side of the road should be connected and made continuous at the time of track removal.

It is anticipated that Burlington Northern will contract out the salvage of the track and signal hardware at some time in the future. A large portion of the long-term improvement costs at this site will probably be paid for by Burlington Northern.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Track & Crossing Signal Removal	-	\$3,500
30	lf	Install Guard Rail	\$9	<u>270</u>
Total Cost:				\$3,770

RECOMMENDED IMPROVEMENTS



Scale in Feet

FRONTAGE ROAD AT INTERSTATE 15 UNDERPASS

g
c
1
+
i

Figure No.



Jefferson Co.

DETERMINATION OF HAZARD INDEX

Site Number 1 Date December, 1982

Site Description I-15 Frontage Road at Underpass

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	<u>1.25</u> acc/yr	<u>30</u>	x 0.164	= <u>4.92</u>
Accident Rate	<u>3.4</u> acc/MVE	<u>52</u>	x 0.225	= <u>11.70</u>
Accident Severity	<u>13,380</u> dollars	<u>72</u>	x 0.191	= <u>13.75</u>
Volume/Capacity Ratio	<u>.51</u>	<u>81</u>	x 0.082	= <u>6.64</u>
Sight Distance Ratio	<u>.42</u> (wt. avg.)	<u>100</u>	x 0.074	= <u>7.40</u>
Driver Expectancy	<u>3.5</u> (wt. avg.)	<u>58</u>	x 0.149	= <u>8.64</u>
Information System Deficiencies	<u>2.8</u> (wt. avg.)	<u>47</u>	x 0.115	= <u>5.41</u>

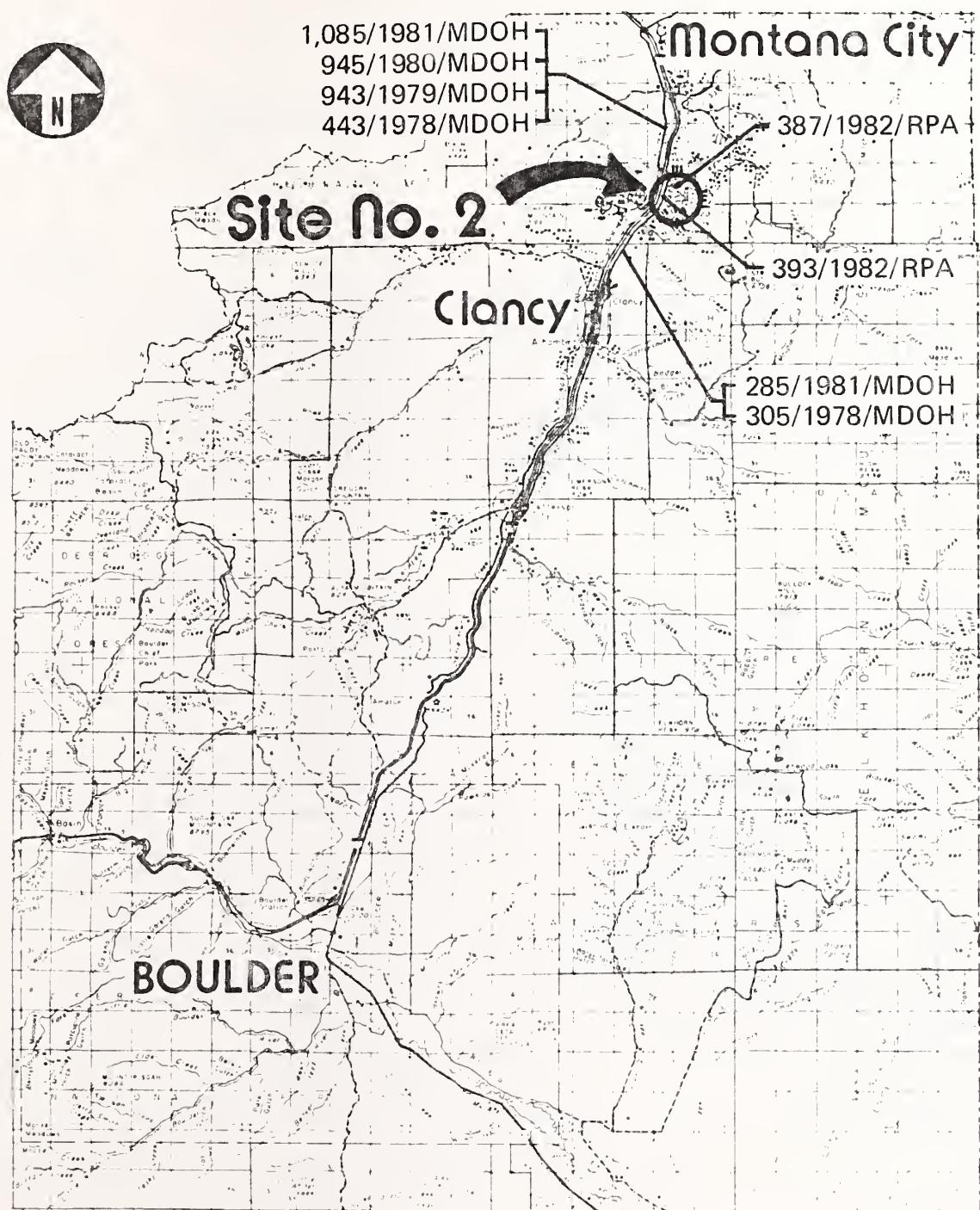
Hazard Index: 58.46

Cost of Recommended Improvements: \$2,408

Cost Factor: 97

Priority Index = Hazard Index x .75 + Cost Factor x .25

58.46 x .75 + 97 x .25 = 68.10



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
MAIN ENTRANCE GRUBER ESTATES

Figure No.
2-A
 Jefferson Co.

SITE #2

MAIN ENTRANCE TO GRUBER ESTATES

A. Location

Site #2 is located on the I-15 Frontage Road approximately 2.6 miles south of the interchange at Montana City. The site consists of the intersection of the main entrance road to Gruber Estates with the I-15 Frontage Road. Gruber Estates is a major rural residential subdivision in northern Jefferson County, and many of its residents commute to and from Helena on a daily basis. The location of this site and all available traffic count data is presented in Figure 2A.

B. Existing Conditions

The I-15 Frontage Road at Site #2 has an asphalt pavement surface that is typically 24 feet wide. A double yellow centerline delineates two 12-foot driving lanes. Grades on the Frontage Road at this location are constant at 4.3 percent and slope toward the north. The Gruber Estates Road is a gravel-surfaced roadway that is typically 20 feet wide; however, roadway width increases to approximately 40 feet near the intersection. Road grades on the Gruber Estates Road are approximately 2.4 percent to the east at the intersection. The road briefly levels out and then increases to a 6.4 percent grade at a hill east of the intersection. Signing on the north approach to the intersection consists of a "School Bus Stop Ahead" sign (S3-1) located approximately 950 feet from the intersection and a non-standard school bus stop sign located at the intersection. Signing on the south approach to the intersection is similar. Traffic on the Gruber Estates Road is regulated at the intersection by a stop sign. No speed limits are posted within the site; however, 55 mph is the generally accepted travel speed on the Frontage Road. Existing conditions at Site #2 are depicted in the sketch (Figure 2B) and photographs (Plate 2) accompanying this analysis.

Twenty-four-hour counts of traffic at the site were collected by the Montana Department of Highways and Robert Peccia & Associates. This data was used to determine that the average daily traffic (ADT) for this location on the I-15 Frontage Road and the Gruber Estates Road was 393 and 387 vehicles, respectively. Other traffic count data for area roadways is presented in Figure 2A.

C. Accident History

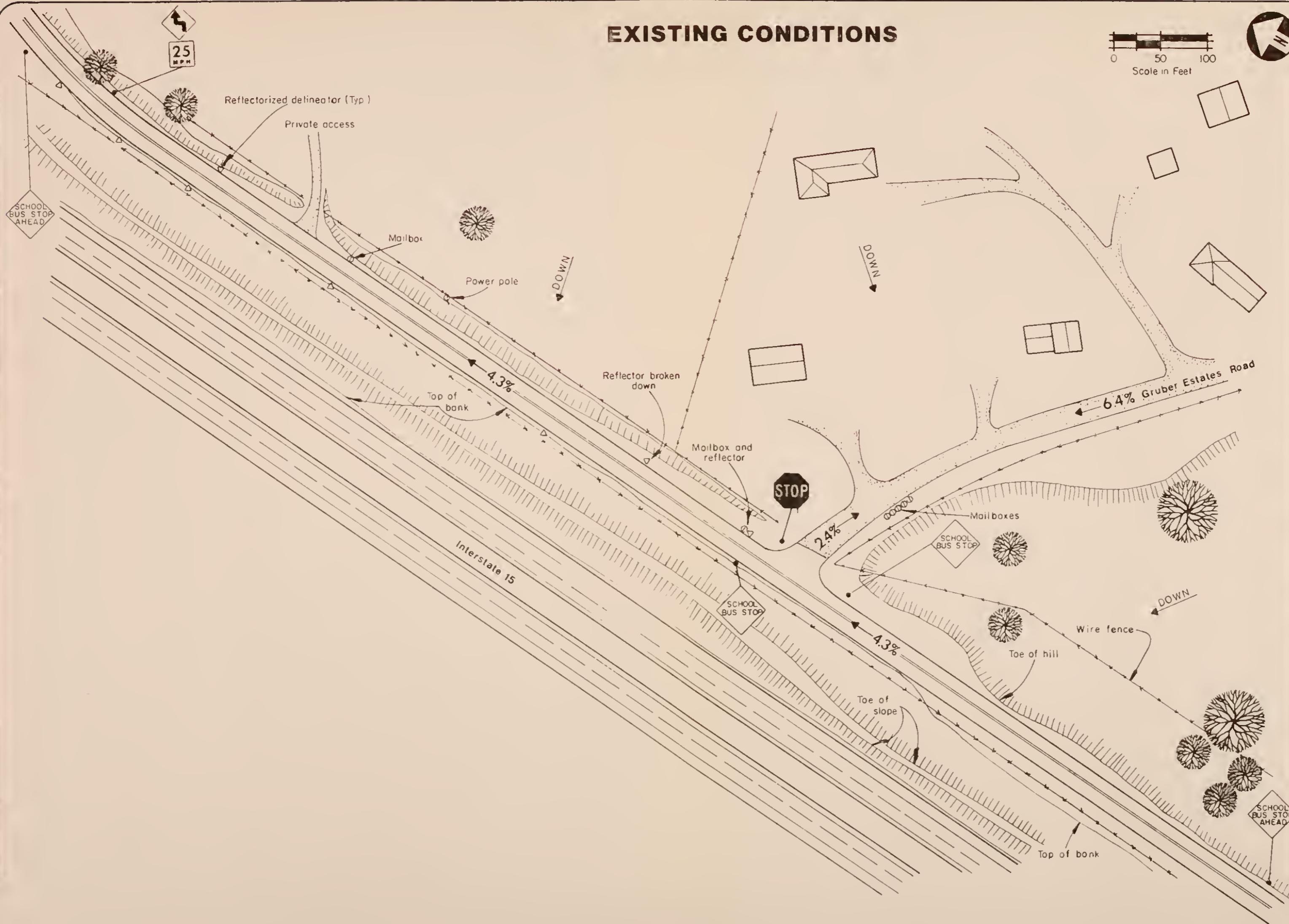
A total of three accidents were reported at Site #2 during the four-year study period. One of the three accidents resulted in injuries to a total of three persons. Two of the three accidents were fixed-object collisions which occurred during snowy or icy road conditions. In both cases, drivers lost control of their vehicles and left the roadway. Because of the steep area

**FRONTAGE ROAD AT MAIN
ENTRANCE GRUBER ESTATES**

Site no. 2

Figure No.
2-B
Jefferson Co.

EXISTING CONDITIONS



Existing Site Conditions



Site 2 as viewed from the north approach. Road grades on the Frontage Road are consistent at 4.3 percent.



View of the south approach to the site. Note the centerline striping and delineation.



View at the intersection of the Gruber Estates Road and the Frontage Road. Note the steep area adjacent to the roadway.



View of the east approach to the intersection. Note the approach grade at the intersection and the steep areas adjacent to the roadway.

COLLISION DIAGRAM

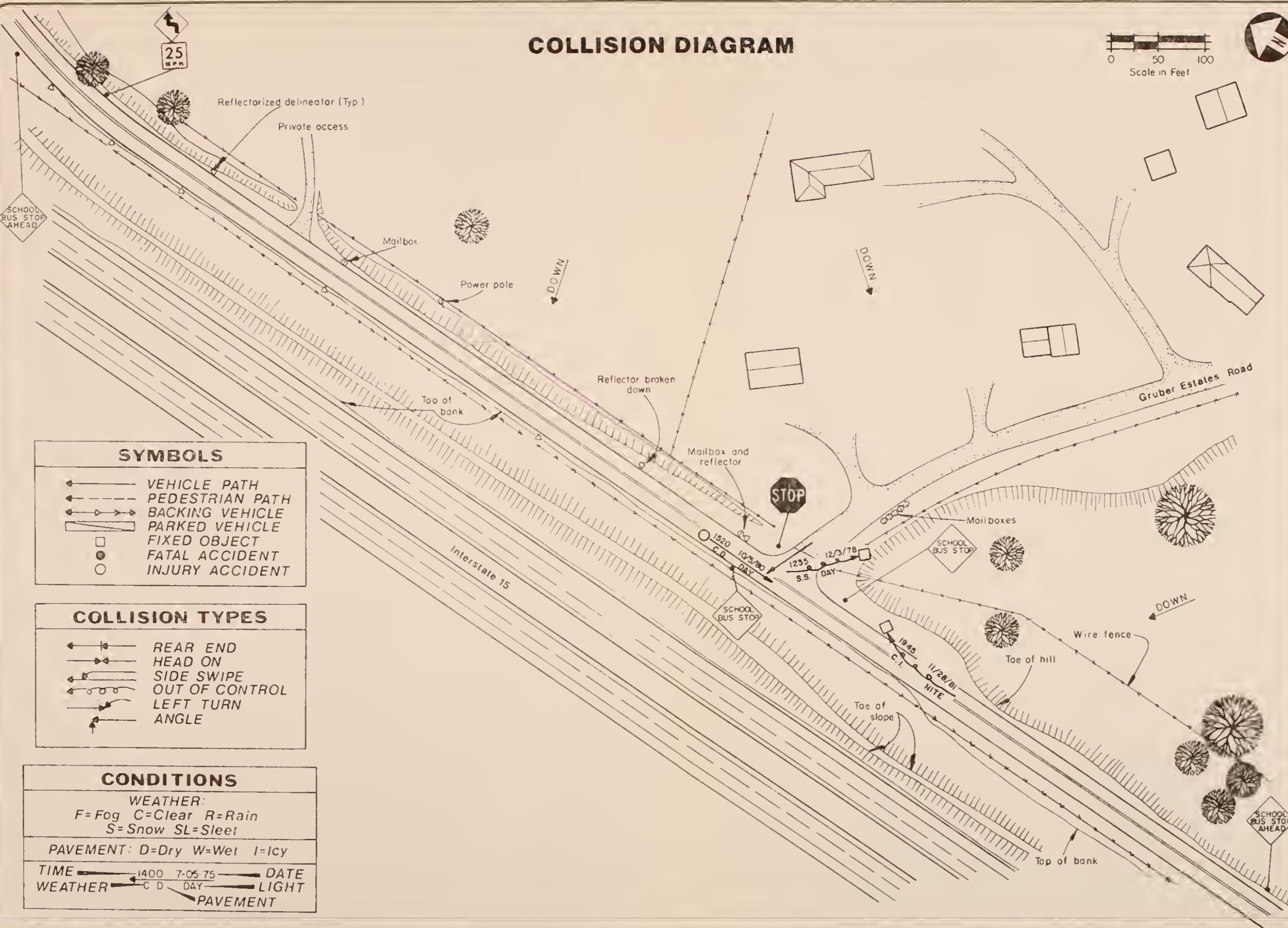
FRONTAGE ROAD AT MAIN ENTRANCE GRUBER ESTATES

Q. C. C. C. C. C.

Figure No.

2.C

Jefferson Co.



ACCIDENT DATA

Main Entrance to Gruber Estates

SITE NUMBER 2

ACCIDENT PERIOD 1978 - 1981

**NUMBER OF ACCIDENTS
BY YEAR**

1978	1979	1980	1981
1		1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
2						1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
									1	1	1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
											1			1				1					

**NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS**

Day-light	Dark	Dawn	Dusk
2	1		

**NUMBER OF ACCIDENTS
BY ROAD CONDITIONS**

Dry	Wet	Snow	Ice	Other
1		1	1	

**NUMBER OF ACCIDENTS
BY WEATHER CONDITIONS**

Clear	Rain	Snow	Fog
2		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
1			2						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1			2					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury			1	
Fatality				
Property Dam. Only	1			1

**NUMBER OF ACCIDENTS
ALCOHOL INVOLVED**

0

south of the Gruber Estates Road adjacent to the Frontage Road, the vehicles were pulled down the slope when one wheel left the edge of the road. The third accident occurred at the intersection, and was a two-vehicle angle collision. The driver of the vehicle approaching the intersection on the Gruber Estates Road was unable to stop, and struck a passing vehicle on the Frontage Road. Two of the three accidents occurred during the day under clear weather conditions. The major contributing circumstance to the reported accidents at this site appears to be excessive speed for road conditions. The accident locations and pertinent data for each accident is presented in Figure 2C.

The accident rate at this location is 3.9 accidents per million vehicles entering.

D. Recommendations

Several of the existing signs at this location are not warranted, while other appropriate signs are missing. The short-term improvements outlined below address these problems by upgrading the signing at this location.

1. The existing school bus stop signs located on the Frontage Road at this intersection are ineffective. The use of these signs has been discontinued by the State, and is not recommended. The advance warning school bus stop ahead signs (S3-1) on both approaches adequately notify motorists of the possibility of a school bus stop ahead. The "School Bus Stop" signs at this intersection are of little value to drivers, and should be removed.
2. This intersection should be identified on the approaches. Side road warning signs (W2-2) should be installed on the north and south legs on the Frontage Road 750 feet in advance of the intersection. In addition, a stop ahead warning sign (W3-1) should be installed approximately 400 feet east of the stop sign to notify drivers in advance of the intersection. In addition to the other signs at this location, a large double directional arrow (W1-7, 48" x 24") should be placed on the west side of the intersection. The double arrow should be located so it is visible to approaching traffic from the east for at least 500 feet.
3. To further identify the location of the entrance to Gruber Estates, two amber reflectors (Design D, 4" x 8", bi-directional) should be installed on either side of the entrance road. These amber delineators will help motorists to define the exact location of the side road at night.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Remove School Bus Stop Signs	\$35	\$ 70
2	ea	Install Side Road Warning Signs (W2-2)	\$130	260
1	ea	Install Stop Ahead Warning Sign (W3-1)	\$130	130
1	ea	Install Large Double Directional Arrow (W1-7, 48" x 24")	\$163	163
2	ea	Install Reflectorized Delin- eators (Design D, amber, 4" x 8", bi-directional)	\$28	<u>56</u>
Total Cost:				\$679

Benefit/Cost Ratio: 1.4

Long-Term Improvements

The steep drop-offs adjacent to the entrance road to Gruber Estates constitute a major hazard to any vehicles leaving the road at this location. The shoulder slopes are quite steep and could cause vehicles to roll, thereby compounding the severity of an accident. It is recommended that guard rail be installed on both sides of the entrance road and extending along the Frontage Road. In this manner, vehicles will be prevented from leaving the roadway if they skid at the entrance to Gruber Estates.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
400	lf	Install Guard Rail	\$9	\$3,600

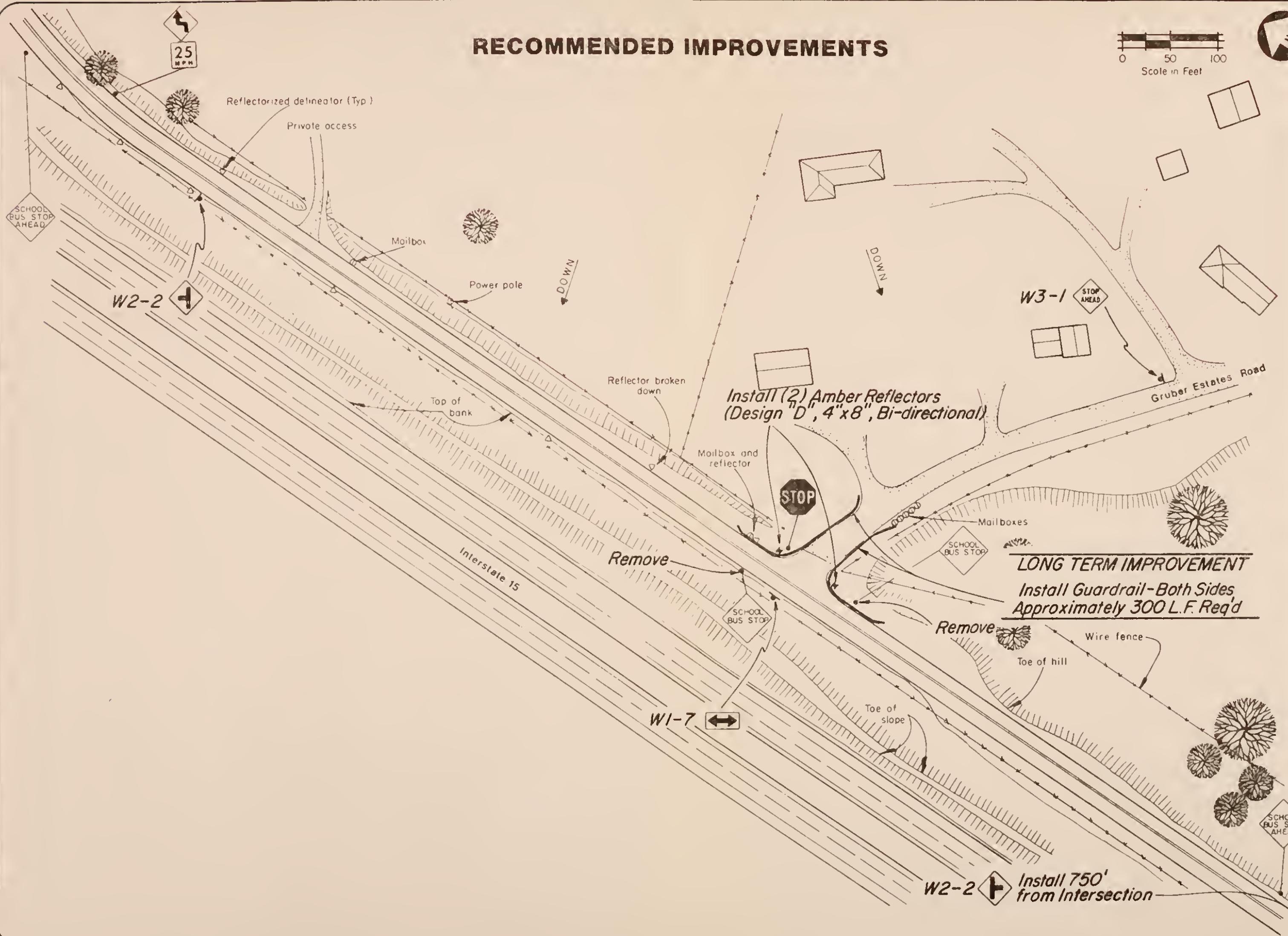
FRONTAGE ROAD AT MAIN
ENTRANCE GRUBER ESTATES

Site No. 2

Figure No.
2-D
Jefferson Co.

RECOMMENDED IMPROVEMENTS

0 50 100
Scale in Feet



DETERMINATION OF HAZARD INDEX

Site Number 2 Date December, 1982

Site Description Main Entrance to Gruber Estates

Indicator	Data Value	Indicator		
		Value	Weight	Partial H.I.'s
Number of Accidents	<u>.75</u> acc/yr	<u>22</u>	x 0.164	= <u>3.61</u>
Accident Rate	<u>3.9</u> acc/MVE	<u>58</u>	x 0.225	= <u>13.05</u>
Accident Severity	<u>10,633</u> dollars	<u>66</u>	x 0.191	= <u>12.61</u>
Volume/Capacity Ratio	<u>.18</u>	<u>36</u>	x 0.082	= <u>2.95</u>
Sight Distance Ratio	<u>2.2</u> (wt. avg.)	<u>0</u>	x 0.074	= <u>0</u>
Driver Expectancy	<u>2.2</u> (wt. avg.)	<u>37</u>	x 0.149	= <u>5.51</u>
Information System Deficiencies	<u>2.0</u> (wt. avg.)	<u>33</u>	x 0.115	= <u>3.80</u>

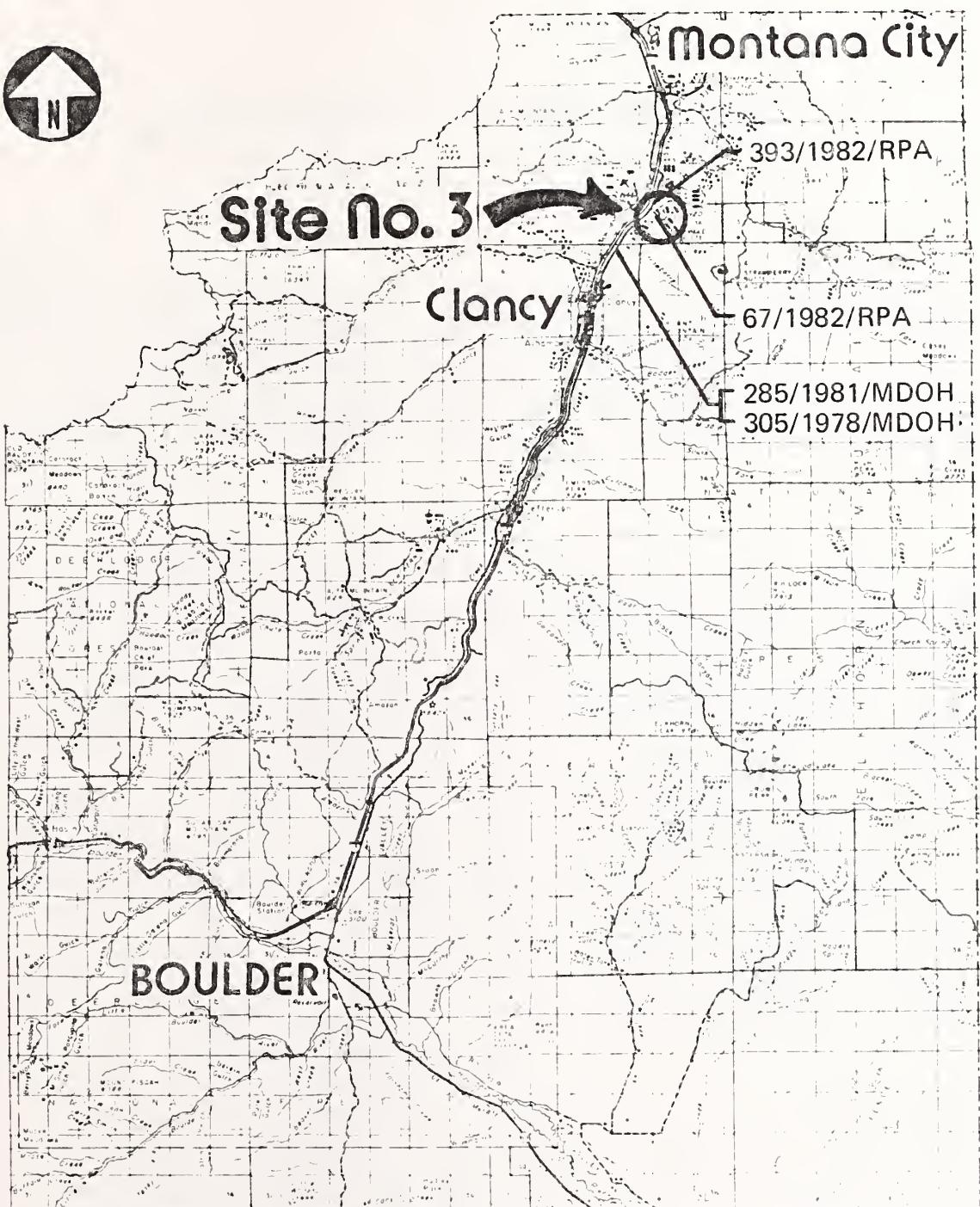
Hazard Index: 41.53

Cost of Recommended Improvements: \$679

Cost Factor: 98

Priority Index = Hazard Index x .75 + Cost Factor x .25

41.53 x .75 + 98 x .25 = 55.65



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
SOUTH ENTRANCE GRUBER ESTATES

Figure No.
3-A
Jefferson Co

SITE #3

SOUTH ENTRANCE TO GRUBER ESTATES

A. Location

Site #3 is located on the I-15 Frontage Road at its intersection with the south entrance to Gruber Estates approximately 2.85 miles south of the Montana City interchange. This site consists of a "T" intersection and its approaches. Land within the area of this site is primarily used for rural residential development. The location of this site and the available traffic data is presented in Figure 3A.

B. Existing Conditions

The I-15 Frontage Road at Site #3 is an asphalt-paved roadway with a general width of 24 feet. Yellow centerline striping is used to delineate two 12-foot driving lanes and to restrict passing by northbound drivers at this location. Road grades on the Frontage Road are consistent and decrease at about 4.3 percent to the south. The South Gruber Estates Road is a gravel-surfaced roadway that is typically 18 feet wide. The grade on this road is quite steep, averaging 11.4 percent toward the intersection. All roadways within the site are in good condition. Signing on the Frontage Road north of the intersection consists of a "School Bus Stop Ahead" sign (S3-1) located approximately 550 feet north of the intersection and a nonstandard "School Bus Stop" sign located just north of the intersection. Due to the steep terrain north of the Gruber Estates access road and the placement of the sign, sight distance to the north is limited to less than 100 feet. There are no posted speed limit signs within Site #3. The existing conditions at this location are depicted in Figure 3B and in Plate 3.

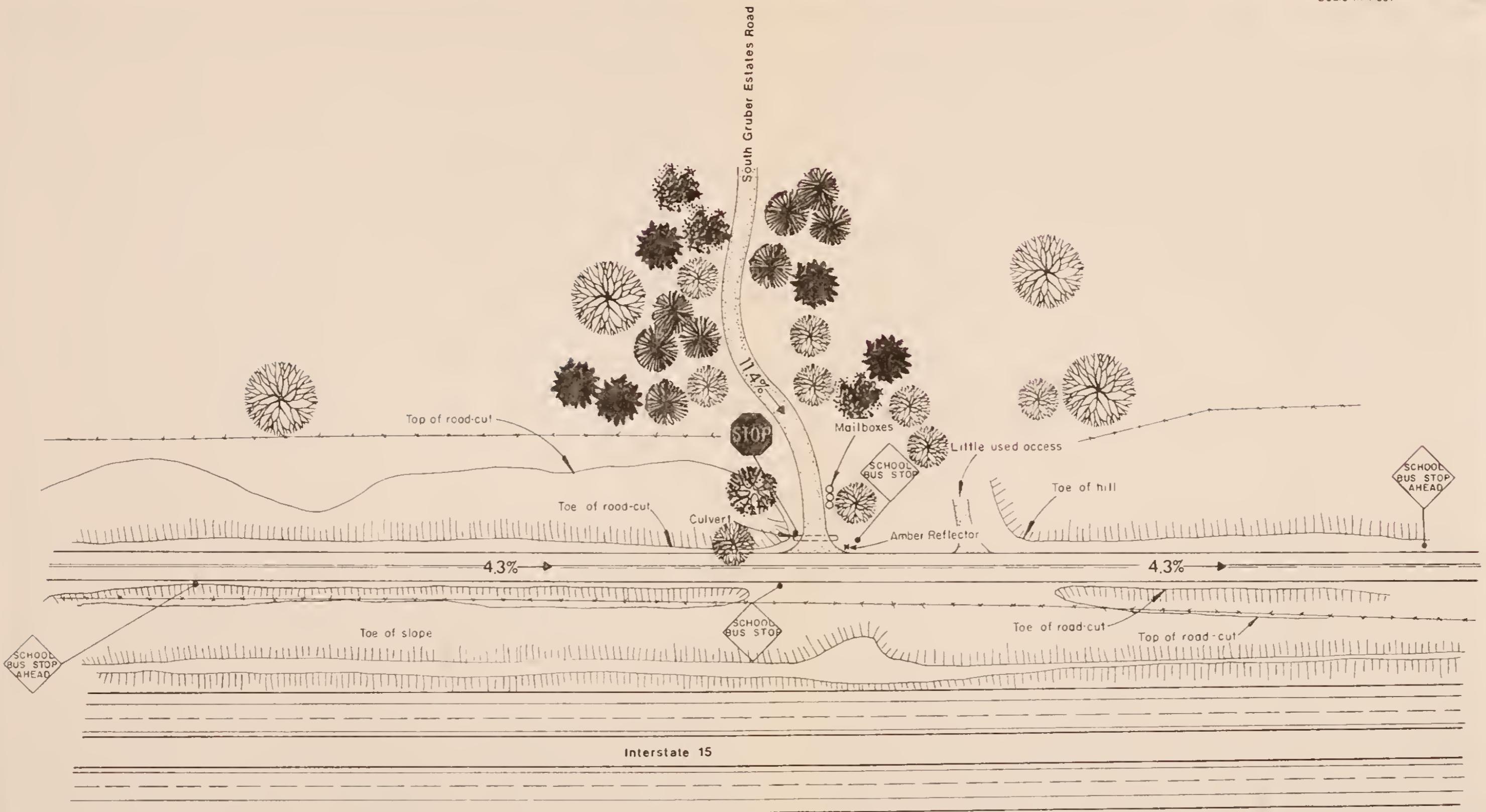
Traffic data for the roadways within Site #3 was collected by Robert Peccia & Associates during November, 1982. Counts of 24-hour traffic volumes were utilized to determine the average daily traffic (ADT) for this roadway. Based on this data, the ADT for the I-15 Frontage Road and the south access to Gruber Estates was determined to be 393 vehicles and 67 vehicles, respectively.

C. Accident History

Only one accident was reported at this site during the four-year study period. This accident, which resulted in injuries to both the driver and passenger of the vehicle, occurred late at night under clear and dry weather and road conditions. The driver of the vehicle lost control of the vehicle just south of the intersection, overcorrected, and left the roadway, rolling the vehicle several times. The major contributing circumstance to this accident was listed as drinking. The location of this accident is depicted in Figure 3C.

EXISTING CONDITIONS

0 50 100
Scale in Feet



FRONTAGE ROAD AT SOUTH
ENTRANCE GRUBER ESTATES

Site no. 3

Figure No.
3-B
Jefferson Co.

Existing Site Conditions



View of the north approach to the intersection. Note the hidden nature of the south Gruber Estates Road at left.



View of the intersection of the I-15 Frontage Road and the south entrance to Gruber Estates.



View of the south approach to the intersection. The existing signing and pavement markings are similar on the north approach.

The terrain, alignment change, and 11.4 percent grade allow motorists to see the stop sign only 150 feet in advance of the intersection on the east approach.

FRONTAGE ROAD AT SOUTH ENTRANCE GRUBER ESTATES

Site No. 3

Figure No.
3-C
Jefferson Co.

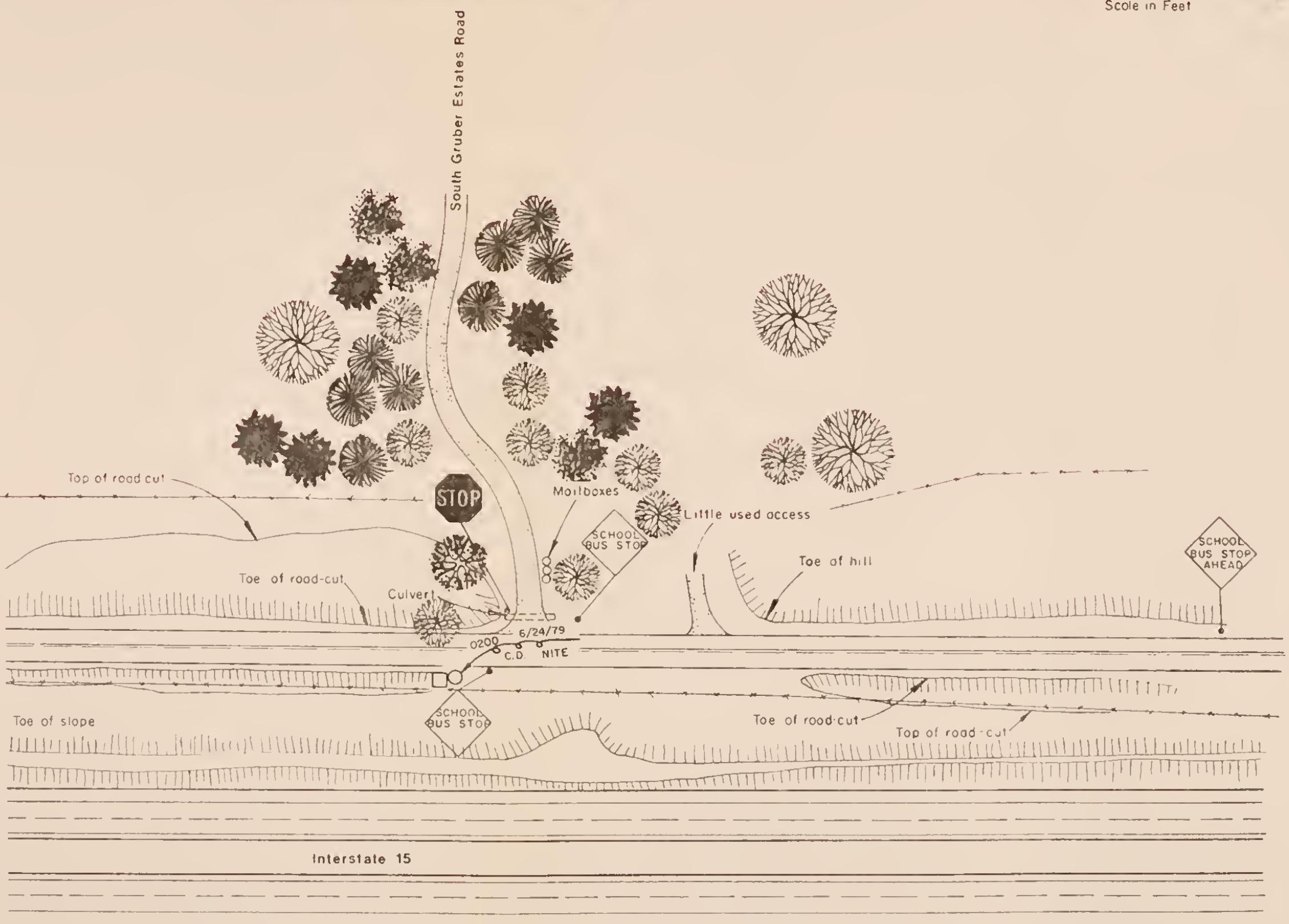
COLLISION DIAGRAM



SYMBOLS	
←	VEHICLE PATH
→	PEDESTRIAN PATH
→→→	BACKING VEHICLE
→→→→	PARKED VEHICLE
□	FIXED OBJECT
●	FATAL ACCIDENT
○	INJURY ACCIDENT

COLLISION TYPES	
→→	REAR END
→→	HEAD ON
→→	SIDE SWIPE
→→→	OUT OF CONTROL
→→→	LEFT TURN
→→→→	ANGLE

CONDITIONS	
WEATHER:	
F=Fog	C=Clear
R=Rain	
S=Snow	SL=Sleet
PAVEMENT: D=Dry	W=Wet
I=Icy	
TIME	1400
WEATHER	7-05-75
	DATE
C. D.	DAY
PAVEMENT	LIGHT



ACCIDENT DATA

South Entrance to Gruber Estates

SITE NUMBER 3

ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
	1		

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
				1		

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					1						

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
	1																						

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
	1			

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
	1		

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swi-pe	Non-Col	Head-on	Backing
			1						

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
	1							

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
		1		

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

Injury
Fatality
Property
Dam. Only

The accident rate for this site is 1.6 accidents per million vehicles entering.

D. Recommendations

The steep, winding approach to this intersection from the east presents a major problem at this site. The lack of adequate sight distance caused by the steep banks adjacent to the east approach is also a problem. The short-term improvements listed below deal with upgrading the existing signing system, while the long-term improvements address the sight distance limitations.

1. The existing school bus stop signs located on the Frontage Road adjacent to the intersection should be removed. The use of this particular sign has been discontinued state-wide because of its ineffectiveness. It is felt that the existing "School Bus Stop Ahead" warning sign (S3-1) located on the north and south approaches adequately warn motorists of the upcoming situation.

2. The intersection should be identified through the use of side road warning signs (W2-2). These signs should be placed 750 feet from the intersection on both approaches on the Frontage Road, where they will alert motorists to the intersection and the possibility of side road traffic.

In addition, amber reflectors should be used to identify the exact location of the side road approach. One such delineator is presently located on the south side of the Gruber Estates access road. A similar reflectorized delineator (Design D, 4" x 8", amber, bi-directional) should be installed adjacent to the north side of the entrance road.

3. To aid westbound motorists in identifying the intersection, a large double directional arrow (W1-7, 48" x 24") should be placed on the west side of the intersection. This arrow sign should be located where it will be visible to traffic from as far back on the approach as possible. Considering the limited view of the intersection available to motorists, a stop ahead warning sign (W3-1) should also be installed 500 feet from the intersection on the east approach.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Remove School Bus Stop Signs	\$35	\$ 70
2	ea	Install Side Road Warning Signs (W2-2)	\$130	260
1	ea	Install Large Double Directional Arrows (W1-7, 48" x 24")	\$163	163
1	ea	Install Stop Ahead Warning Sign (W3-1)	\$130	130
1	ea	Install Reflectorized Delineators	\$28	<u>28</u>
Total Cost:				\$651

Benefit/Cost Ratio: 1.3

Long-Term Improvements

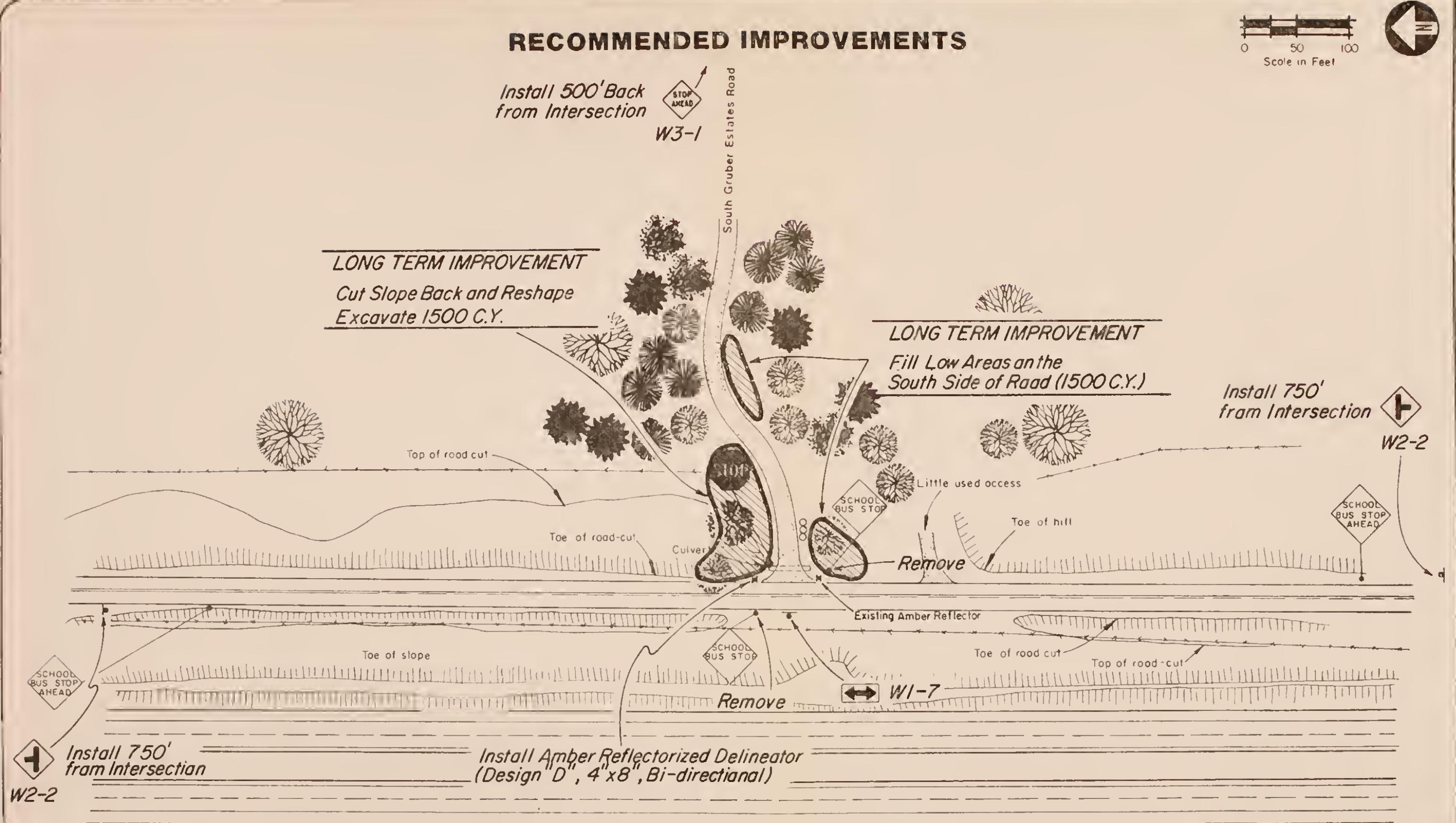
The limited sight distance at this site is caused by the up-sloping embankment on the north side of the Gruber Estates access road. This bank blocks the westbound motorists' view of the intersection and also limits the view of the north approach for motorists attempting to enter the Frontage Road. This embankment should be cut back at least five feet and should be reshaped. Approximately 1,500 cubic yards of material should be removed and deposited on the south side of the Gruber Estates road as well as used to fill the low areas adjacent to the intersection and the inside of the first curve to the east. The low areas should be filled and sloped away from the road at a 6:1 slope. This will provide a safe overrun area for vehicles leaving the road at this location, and will minimize the severity of accidents. The embankment on the north side of the access road should be recontoured to provide a clear view of the intersection from uphill on the east approach. This improvement will also give stopped motorists a view of the north approach without having to "inch out" into the intersection.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1,500	cy	Excavation & Embankment	\$5	\$7,500

FRONTAGE ROAD AT SOUTH ENTRANCE GRUBER ESTATES

Site No. 3



DETERMINATION OF HAZARD INDEX

Site Number 3 Date December, 1982

Site Description South Entrance to Gruber Estates

Indicator	Data Value	Indicator		
		Value	Weight	Partial H.I.'s
Number of Accidents	<u>.25</u> acc/yr	<u>12</u>	x 0.164	= <u>1.97</u>
Accident Rate	<u>1.6</u> acc/MVE	<u>27</u>	x 0.225	= <u>6.08</u>
Accident Severity	<u>12,300</u> dollars	<u>69</u>	x 0.191	= <u>13.18</u>
Volume/Capacity Ratio	<u>.23</u>	<u>40</u>	x 0.082	= <u>3.28</u>
Sight Distance Ratio	<u>.49</u> (wt. avg.)	<u>100</u>	x 0.074	= <u>7.40</u>
Driver Expectancy	<u>4.2</u> (wt. avg.)	<u>70</u>	x 0.149	= <u>10.43</u>
Information System Deficiencies	<u>3.0</u> (wt. avg.)	<u>50</u>	x 0.115	= <u>5.75</u>

Hazard Index: 48.09

Cost of Recommended Improvements: \$651

Cost Factor: 98

Priority Index = Hazard Index x .75 + Cost Factor x .25

48.09 x .75 + 98 x .25 = 60.57





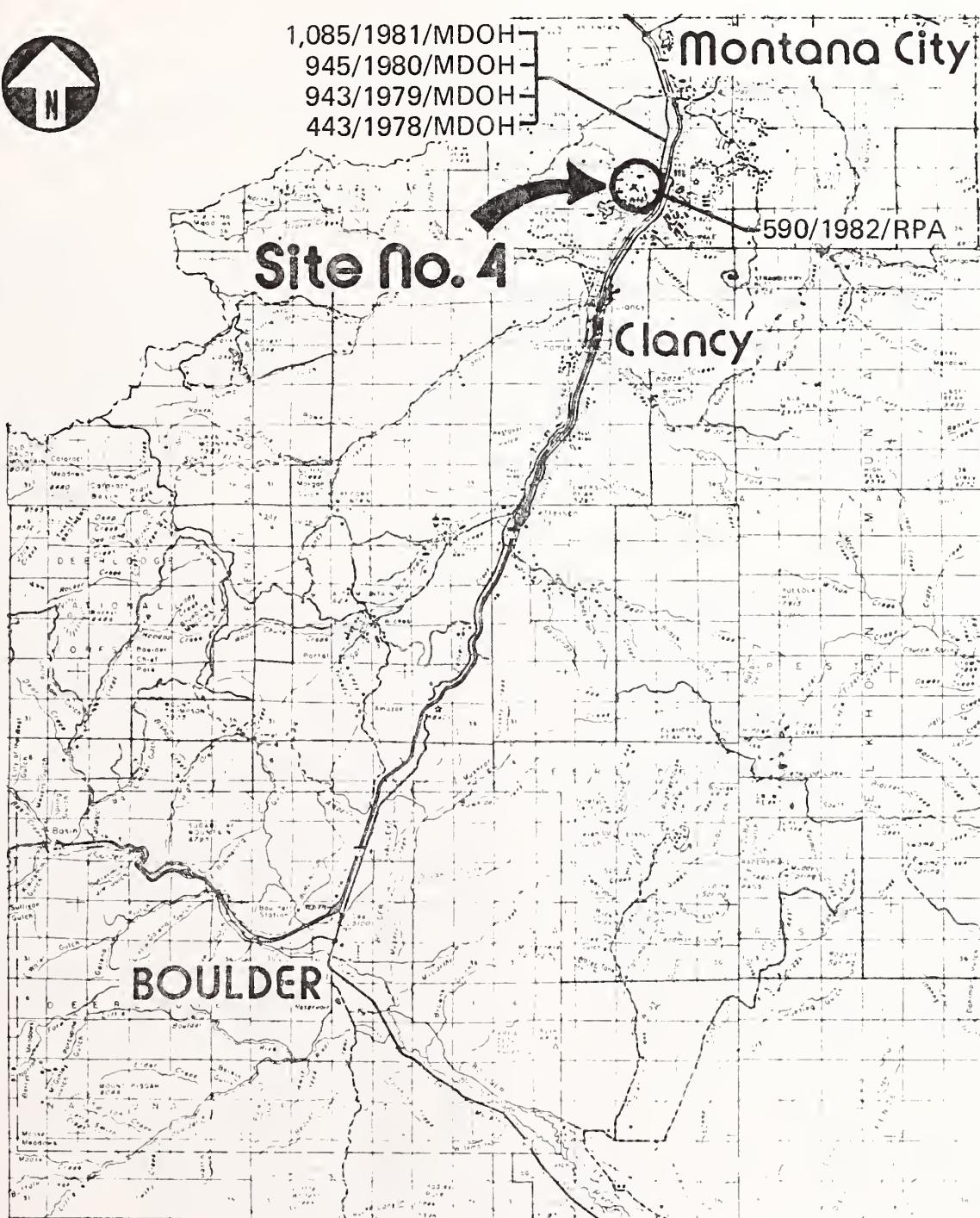
1,085/1981/MDOH
945/1980/MDOH
943/1979/MDOH
443/1978/MDOH

Montana City

590/1982/RPA

Site No. 4

Clancy



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
BLUE SKY HEIGHTS ROAD

Figure No.
4-A
Jefferson Co.

SITE #4

BLUE SKY HEIGHTS ROAD AT PRICKLY PEAR CREEK BRIDGE

A. Location

Site #4 is located on Blue Sky Heights Road approximately 0.7 miles south of its intersection with the I-15 Frontage Road. This site consists of the bridge over Prickly Pear Creek and both approaches to the site. The Blue Sky Heights Road serves residents of Blue Sky Heights and Forest Park Estates, two large rural residential subdivisions in northern Jefferson County. The location of this site and the traffic counts for the roadway are presented in Figure 4A.

B. Existing Conditions

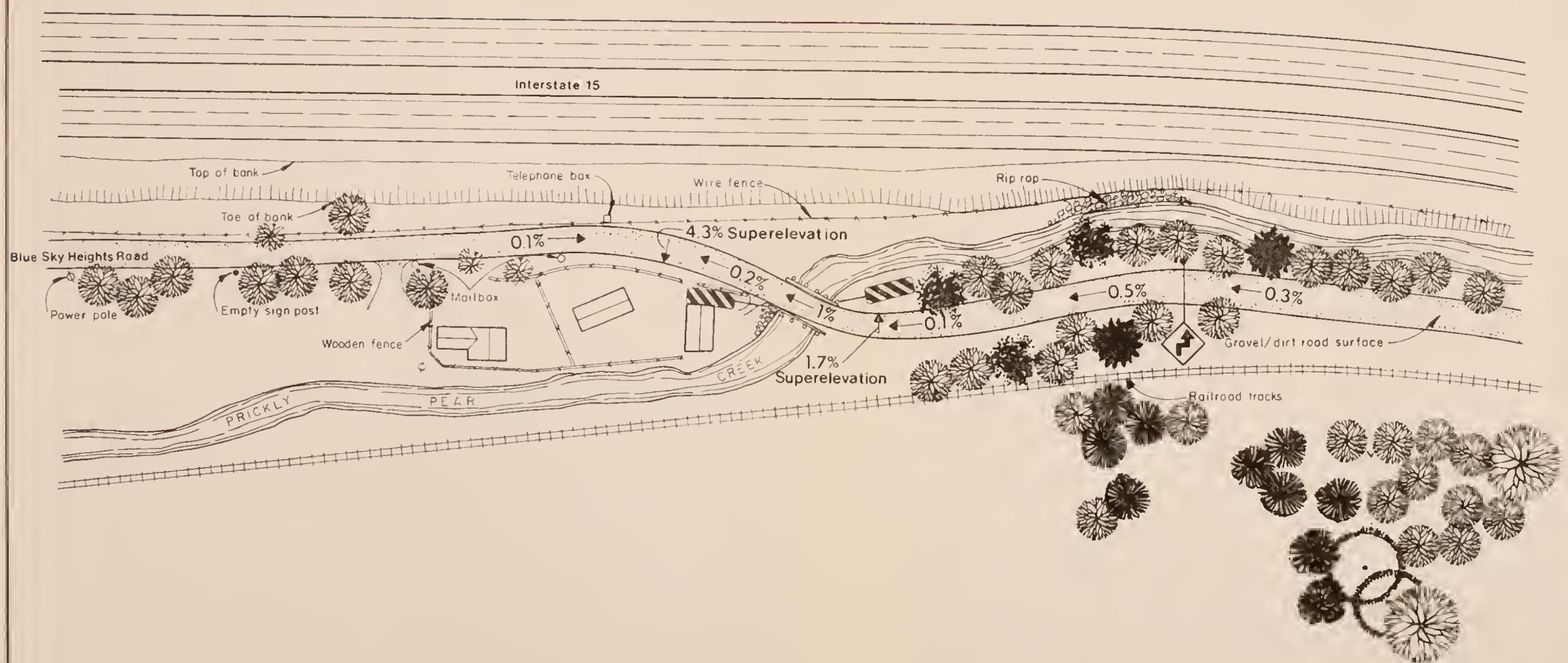
The Blue Sky Heights Road at Site #4 is a gravel-surfaced roadway which is typically 22 feet wide. Road grades throughout the site are consistently flat and do not exceed 1.0 percent. Due to the restrictions imposed by the locations of Prickly Pear Creek and the Burlington Northern railroad line, the present roadway alignment has curves on both approaches to the bridge. The change in roadway alignment and the presence of roadside vegetation tend to limit sight distance somewhat on both approaches. Minimum sight distances range between 210 and 225 feet on each approach to the bridge. This condition has been remedied to some extent in recent months by Jefferson County crews, who have removed approximately 15 to 20 feet of vegetation from both sides of the roadway for approximately 400 feet from the south end of the bridge. Signing at the site consists of a reverse turn sign (W1-3R) located approximately 300 feet south of the bridge. A signpost is located 480 feet north of the bridge; it is assumed that a similar sign was once mounted here. Although no speed limit signs exist within the site, the posted speed limit for the Blue Sky Heights Road is 35 mph.

The Prickly Pear Creek Bridge is a concrete structure built over a series of culverts. The bridge deck is 50 feet long and 21 feet wide. During the Prickly Pear Creek flood of 1981, channels were cut to divert floodwaters around the bridge and minimize damage to the structure. After the flood, both approaches were rebuilt and guard rail was reinstalled on the bridge. The present guard rail is ineffective due to its mounting height and the structurally unsound nature of the guard rail posts. The existing conditions at this site are depicted in Figure 4B and Plate 4.

Traffic data on the Blue Sky Heights Road was collected by Robert Pecchia & Associates during November, 1982. Machine counts of 24-hour traffic volumes were used to determine the average daily traffic (ADT) for this site. Based on this data, the ADT for this location on Blue Sky Heights Road is 590 vehicles.

EXISTING CONDITIONS

0 50 100
Scale in Feet



BLUE SKY HEIGHTS ROAD AT
PRICKLY PEAR CREEK BRIDGE

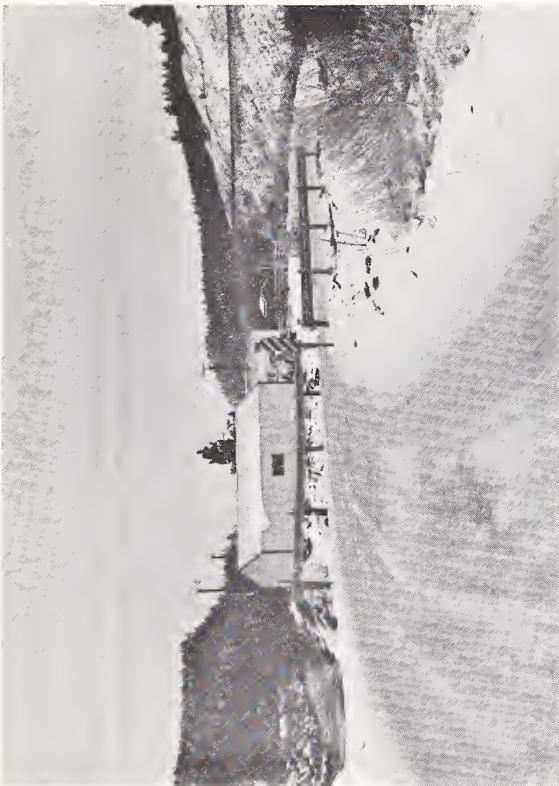
Site No. 4

Figure No.
4-B
Jefferson Co.

Existing Site Conditions



View of the north approach to the Prickly Pear Creek Bridge.
Sight distance on this approach is limited to 210 feet by
roadside vegetation.



View of the bridge from the south approach. The superelevation in this approach is flat and the guard rail on the north side of the bridge is not securely mounted.



View of change in road alignment at the bridge. Note the lack of a left object marker and the temporary installation of the right object marker.



View of south approach to the bridge. Note advance turn warning sign and the area of trimmed back vegetation to the left of the photo.

C. Accident History

A total of five accidents were reported at this site during the four-year study period; only one of which resulted in an injury. Three of the five accidents occurred on the bridge itself and two occurred on the north approach to the structure. One fixed-object collision, a sideswipe collision, and a head-on collision were reported on the bridge. A single-vehicle roll-over accident and an angle collision were reported on the north approach. All five accidents occurred during the day under clear weather conditions. Road conditions at the site were icy during three of the five accidents. It appears that excessive speed for road conditions and a lack of sight distance are the major contributing circumstances to the reported accidents at this site. Alcohol was not involved in any of the accidents at Site #4. The composite collision diagram for this site is depicted in Figure 4C.

The accident rate for this location on the Blue Sky Heights Road is 5.8 accidents per million vehicles entering.

D. Recommendations

The sharp changes in road alignment and the poor angle of the bridge make this site difficult for motorists to negotiate. The short-term improvements outlined below concentrate on improving the signing and the sight distance at this site.

1. A vehicle equipped with a ball bank indicator was used to determine that 15 mph is the maximum safe speed for the curves at this site. Reverse turn warning signs (W1-3) with 15 mph advisory speed plates (W13-1) should be posted on both approaches. A speed plate should be mounted with the existing reverse turn sign on the south approach. The warning sign and speed plate for the north approach should be mounted on the existing post located approximately 500 feet north of the bridge.
2. A series of chevron warning signs (W1-8) should be installed on the outside of the curves on the bridge approaches. The recommended location and spacing of these chevrons is shown in Figure 4D. These signs will warn motorists of the change in roadway alignment and will lead drivers through the site.
3. The bridge rail ends should be identified through the use of object markers. Although two such markers are presently used to delineate the bridge, two additional object markers (OM-3) are required to completely identify the structure.
4. The guard rail on the northwest side of the bridge is installed too high and is not securely attached to the bridge. In its present condition, the guard rail would not be able to stop a vehicle from going off the bridge. It should therefore be properly reinstalled with strong supports to make it a structurally sound barrier. For additional information concerning the proper installation of bridge guard rails, refer to Montana Department of Highways Standard Specifications (Section 90 and Standard Drawing 85).

SYMBOLS

- VEHICLE PATH
- PEDESTRIAN PATH
- BACKING VEHICLE
- PARKED VEHICLE
- FIXED OBJECT
- FATAL ACCIDENT
- INJURY ACCIDENT

COLLISION DIAGRAM

0 50 100
Scale in Feet



COLLISION TYPES

- REAR END
- HEAD ON
- SIDE SWIPE
- OUT OF CONTROL
- LEFT TURN
- ANGLE

CONDITIONS

WEATHER:

F=Fog C=Clear R=Rain
S=Snow SL=Sleet

PAVEMENT: D=Dry W=Wet I=icy

TIME ————— 1400 7-05-75 ————— DATE
WEATHER ————— C.D. ————— DAY
PAVEMENT ————— PAVEMENT

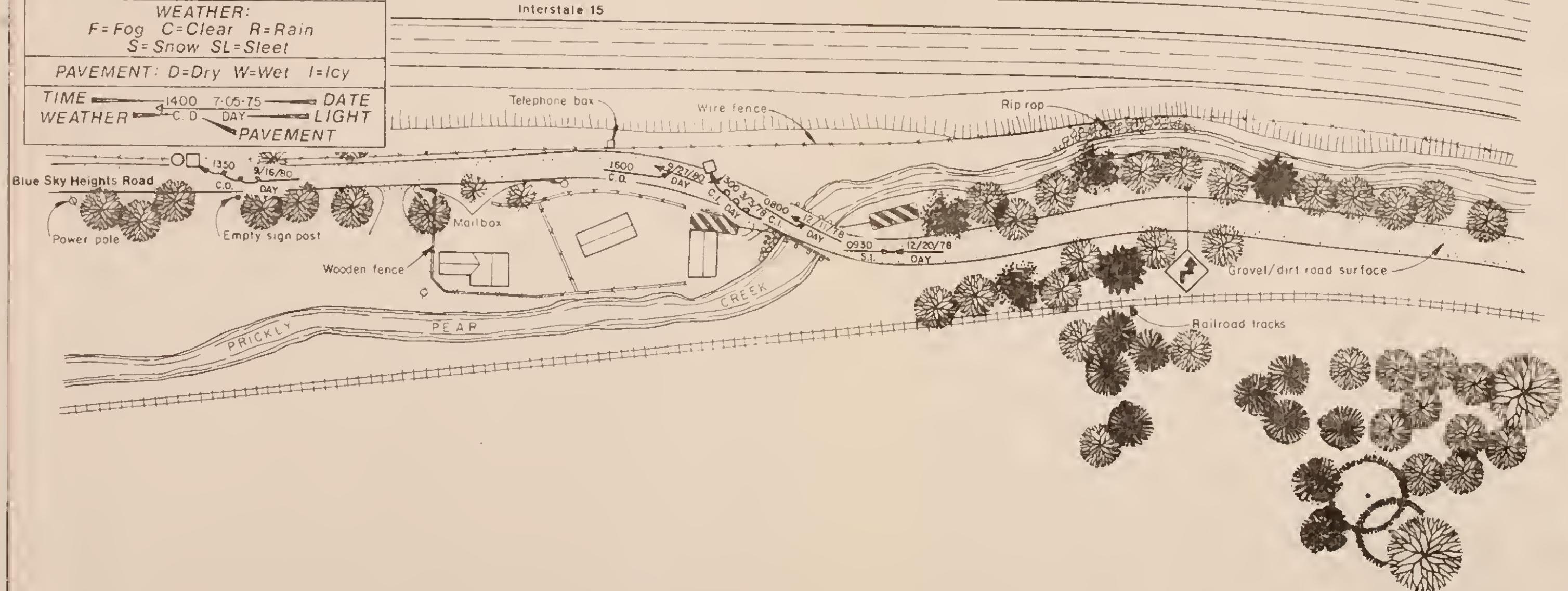


Figure No.

4-C

Jefferson Co.

BLUE SKY HEIGHTS ROAD AT
PRICKLY PEAR CREEK BRIDGE

Site No. 4

ACCIDENT DATA

Blue Sky Heights Road at Prickly Pear Creek Bridge

SITE NUMBER 4

ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
3		2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1	1	1		1	1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		1							2		2

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
							1	1				2			1								

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
5			

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
2			3	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
4		1	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
1			2			1		1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
4			1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury			1	
Fatality				
Property Dam. Only	3		1	

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

0

5. The superelevation of the curve on the south bridge approach is too flat (1.7%) for the radius. The road in the curve should be reshaped to provide a uniform superelevation of .04 ft/ft.

6. The brush adjacent to the road on the north bridge approach tends to block the view of the road. This brush should be cut back to provide additional sight distance at this location.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1	ea	Install Reverse Turn Warning Sign (W1-3) on Existing Post	\$105	\$ 105
2	ea	Install 15 mph Advisory Speed Plate (W13-1)	\$50	100
13	ea	Install Chevron Warning Signs (W1-8)	\$130	1,690
2	ea	Install Object Markers (OM-3)	\$130	260
52	lf	Reinstall Guard Rail	\$5	260
-	Lump Sum	Reconstruct Superelevation in Curve on South Bridge Approach	-	500
-	Lump Sum	Cut Back Brush	-	<u>300</u>
Total Cost:				\$3,215

Benefit/Cost Ratio: 1.3

Long-Term Improvements

The existing alignment of the bridge relative to the roadway is the cause of most of the problems at this site. The optimum solution is to construct a new bridge that will be properly aligned with both approaches. The bridge should have a travel width of 24 feet to safely provide for two-way traffic. The new alignment of the bridge would eliminate the series of sharp curves at this site and provide the necessary sight distance.

A reconstruction project is being planned to provide for the paving of the Blue Sky Heights Road. It is strongly recommended that other roadway alignments be considered as part of the development of this project. The upgraded version of this road should be designed and constructed according to current highway design standards. If practical, other crossing sites over the Prickly Pear Creek should be examined that would allow better approach alignments to the new bridge structure.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Construct New Bridge	-	\$95,000

BLUE SKY HEIGHTS ROAD AT
PRICKLY PEAR CREEK BRIDGE

Site No. 4

Figure No.

4-D

Jefferson Co.

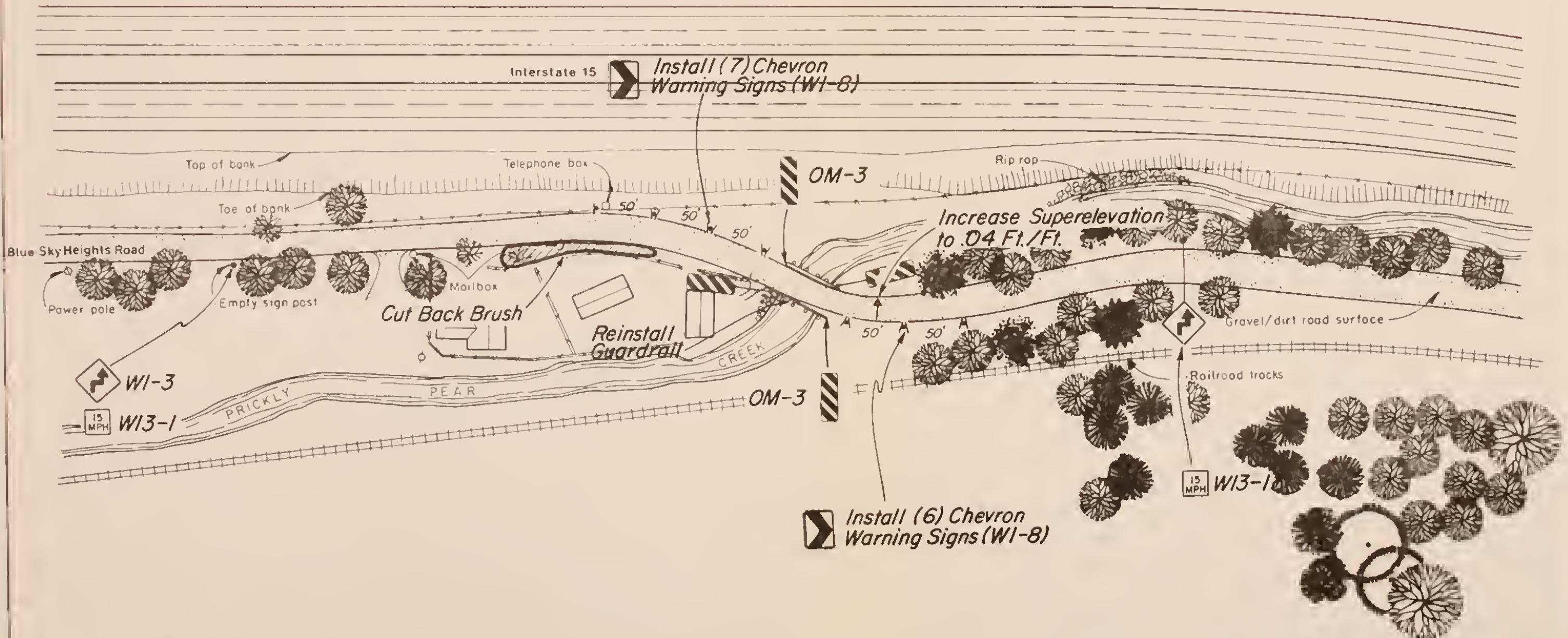
RECOMMENDED IMPROVEMENTS

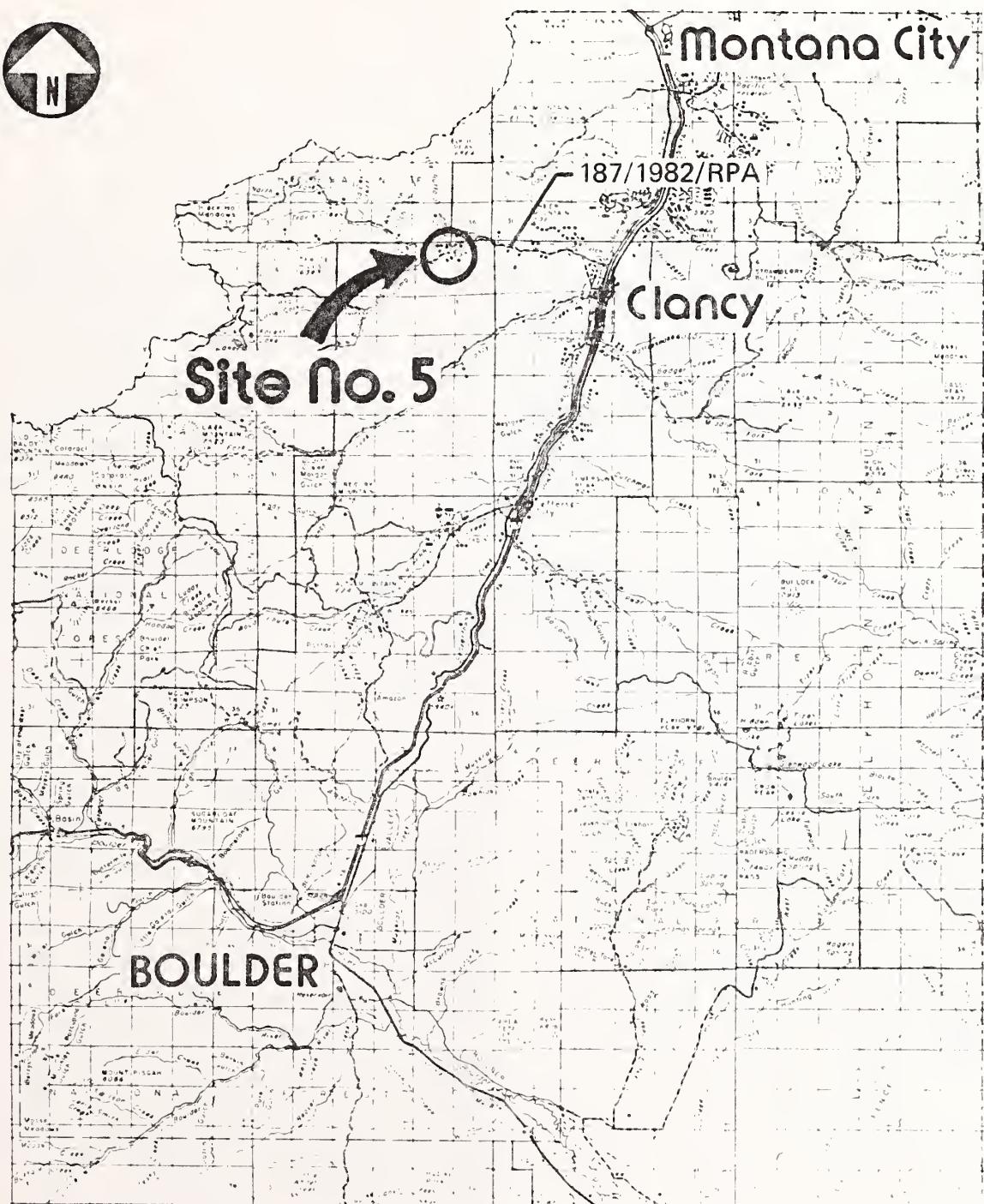
0 50 100
Scale in Feet



LONG TERM IMPROVEMENT

*Construct New Bridge and
Straighten Road Alignment*





Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
LUMP GULCH ROAD

Figure No.
5-A
Jefferson Co.

SITE #5

LUMP GULCH ROAD

A. Location

Site #5 is located on the Lump Gulch Road approximately 3.6 miles west of the I-15 interchange at Clancy. The site is located in gently rolling terrain just north of Lump Gulch Creek, and consists of a series of curves roughly parallel to the course of the creek. Land in the area is primarily used as livestock pasture. Residential development has also occurred near each end of the site. The location of this site and the traffic count data for the Lump Gulch Road are presented in Figure 5A.

B. Existing Conditions

The Lump Gulch Road at Site #5 is a gravel-surfaced roadway varying in width from 18 to 24 feet. The roadway is in fair condition, although numerous locations within the site have a "washboard" surface that is quite rough. Road grades within the site range from a minimum of 1.0 percent near the eastern end of the site to a maximum of 11.2 percent near the western end. Road alignment within the site changes many times due to numerous large rock outcrops on the north side of the roadway. The superelevations through most of the site are effective, and range from 6.6 to 8.8 percent. However, the superelevation through one curve in the central portion of the site is ineffective because it is relatively flat. The change in roadway alignment and grade limit sight distance to approximately 125 feet. Obstructions exist within ten feet of the roadway at numerous locations within the site, and steep areas are found adjacent to the roadway in several parts of the site. At the present time, no signing exists within the site. The existing conditions at Site #5 are depicted in the site sketch (Figure 5B) and in the site photographs (Plate 5) which accompany this analysis.

Traffic data for this section of Lump Gulch Road was collected by Robert Peccia & Associates during November, 1982. Counts of 24-hour traffic volumes were utilized to determine that the average daily traffic (ADT) for this site is 187 vehicles.

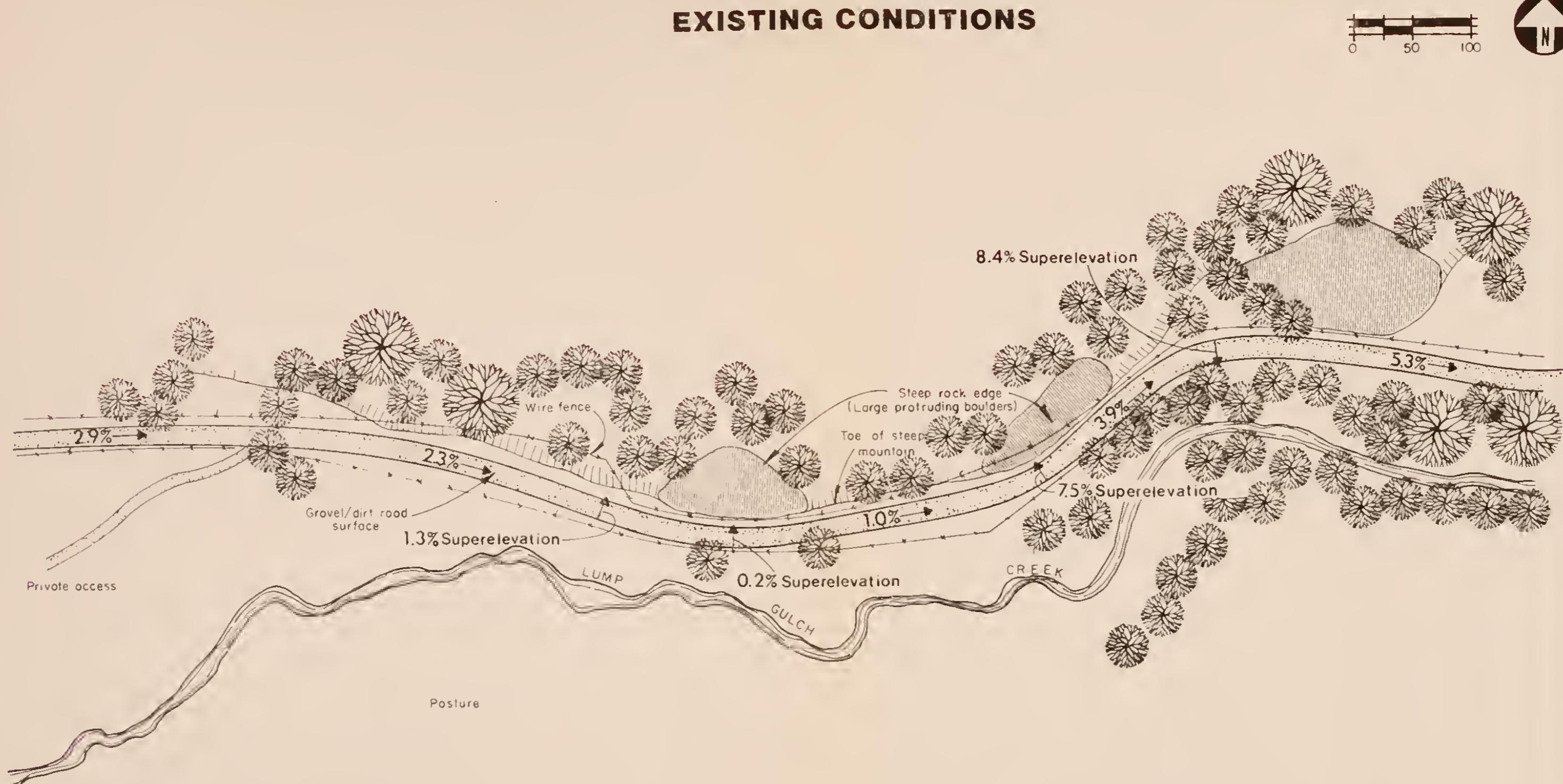
C. Accident History

A total of four accidents were reported at this site during the four-year study period. One of the four resulted in injuries to a total of one person. Three of the four accidents at the site were sideswipe accidents; the remaining accident involved a single vehicle which left the roadway and rolled down a steep area next to the road. All four accidents occurred during the day under clear weather conditions, and three of the four occurred during snowy or icy road conditions. The major contributing circumstances to the accidents at this site appear to be a lack of adequate sight distance,

LUMP GULCH ROAD

Site No. 5

Figure No.
5-B
Jefferson Co.



Existing Site Conditions



View of the Lump Gulch Road in Site 5. Note the rock outcrop, which limits sight distance.



View of the reverse turns in the eastern portion of the site. Note thick roadside vegetation and steep areas adjacent to the roadway in this portion of the site.



View of roadway in the eastern portion of the site. Note the large rock outcrops limit sight distance at several locations in this site. Sight distance is limited to 120 feet at this location.



Large rock outcrops limit sight distance at several locations in this site. Sight distance is limited to 120 feet at this location.

snowy or icy road conditions, and excessive speed for road conditions. Alcohol was not a factor in any accident at this site. The composite collision diagram for Site #5 is depicted in Figure 5C.

The accident rate for this section of the Lump Gulch Road is 14.7 accidents per million vehicles entering.

D. Recommendations

This winding section of the Lump Gulch Road has no signing or delineation. Accident records indicate that the most common accident type is the side-swipe, which is a result of the narrow roadway width and poor roadway conditions. The short-term improvements concentrate on improving signing and delineation, while the long-term improvements address the roadway width problems. The recommended short-term improvements are as follows:

1. Winding road warning signs (W1-5) should be installed on both approaches to this site. A ball bank indicator was used to determine that 20 mph is the maximum safe speed for this section of road. Therefore, 20 mph advisory speed plates (W13-1) should be mounted along with the winding road warning signs. The warning signs should be located approximately 350 feet from the beginning of the curves on both approaches.
2. A series of reflectorized delineators (Design C, 4" x 4", silver, bi-directional) should be installed at this site. The recommended location and spacing of the delineators is shown in Figure 5D. Through the use of these delineators, drivers will be able to better identify the roadway edge and therefore will be able to utilize the full roadway width. The reflectors will also enable snow plow crews to plow the entire width of the road.
3. It is recommended that the County upgrade its plowing and sanding operations along the Lump Gulch Road. The narrow, winding sections of this road become particularly hazardous when icy or snow-packed. The widest possible travelway should be plowed, and hills and curves should be sanded as often as possible. This winter maintenance program will minimize hazards along this section of road.
4. The superelevation of one particular curve in the middle of Site #5 presents a major hazard to motorists. Although the adjacent curves have proper superelevations of 6 to 8 percent, this particular curve is almost flat. This is a very dangerous situation and should be corrected by reconstructing this curve to a uniform grade of .06 ft/ft.

LUMP GULCH ROAD

Site No. 5

Figure No.
5-C
Jefferson Co.

COLLISION DIAGRAM



SYMBOLS	
→	VEHICLE PATH
→—→	PEDESTRIAN PATH
→→→	BACKING VEHICLE
→—→—→	PARKED VEHICLE
□	FIXED OBJECT
●	FATAL ACCIDENT
○	INJURY ACCIDENT

COLLISION TYPES	
→—→	REAR END
→—→	HEAD ON
→—→—→	SIDE SWIPE
→—○—○—○	OUT OF CONTROL
→—→—→	LEFT TURN
→—→—→	ANGLE

CONDITIONS	
WEATHER:	
F=Fog	C=Clear
S=Snow	R=Rain
SL=Sleet	
PAVEMENT: D=Dry	W=Wet
I=Icy	
TIME	DATE
WEATHER	C.D.
	DAY
	LIGHT
	PAVEMENT

ACCIDENT DATA

Lump Gulch Road

SITE NUMBER 5

ACCIDENT PERIOD 1978 - 1981

**NUMBER OF ACCIDENTS
BY YEAR**

1978	1979	1980	1981
1	1	1	1

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1			1		1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1		1			1						1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
													1	2			1						

**NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS**

Day-light	Dark	Dawn	Dusk
4			

**NUMBER OF ACCIDENTS
BY ROAD CONDITIONS**

Dry	Wet	Snow	Ice	Other
1		2	1	

**NUMBER OF ACCIDENTS
BY WEATHER CONDITIONS**

Clear	Rain	Snow	Fog
4			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
						3		1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
3			1					

NUMBER OF ACCIDENTS BY SEVERITY

Injury Fatality Property Dam. Only	1978	1979	1980	1981
				1
	1	1	1	

**NUMBER OF ACCIDENTS
ALCOHOL INVOLVED**

0

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
2	ea	Install Winding Road Warning Signs (W1-5) with 20 mph Advisory Speed Plates (W13-1)	\$180	\$360
24	ea	Install Reflectorized Delin-eators (Design C, 4" x 4", silver, bi-directional)	\$18	432
-	Lump Sum	Reconstruct Curve Superelevation	-	<u>400</u>
Total Cost:				\$1,192

Benefit/Cost Ratio: 3.3

Long-Term Improvements

The winding, narrow nature of this site is the main problem at this location. It appears that the steep rock faces that limit sight distance are on private property. If permission can be obtained from the land owners, these outcroppings should be removed. The embankment on the inside of the curves should be sloped back to allow a minimum sight distance of 200 feet, and the excavated material should be deposited on the inside of the curve at the east end of the site.

In addition to providing adequate sight distance, the roadway should be widened throughout to a minimum width of 22 feet. Since most accidents appear to be directly related to the present roadway width, widening the roadway is the optimum solution to the problem.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
1,500	cy	Rock Excavation & Embankment	\$8	\$12,000
-	Lump Sum	Widen Roadway	-	<u>4,000</u>
Total Cost:				\$16,000

Lump GULCH ROAD

Site No. 5

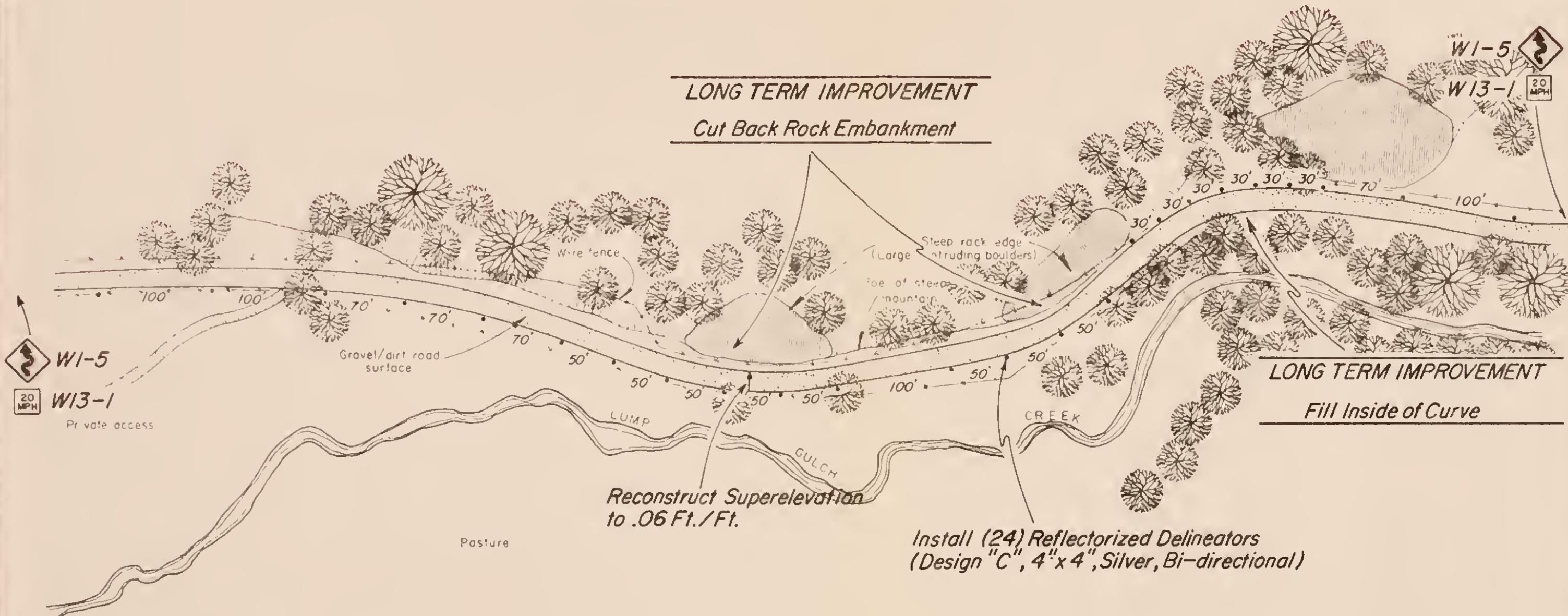
Figure No.
5-D
Jefferson Co.

RECOMMENDED IMPROVEMENTS



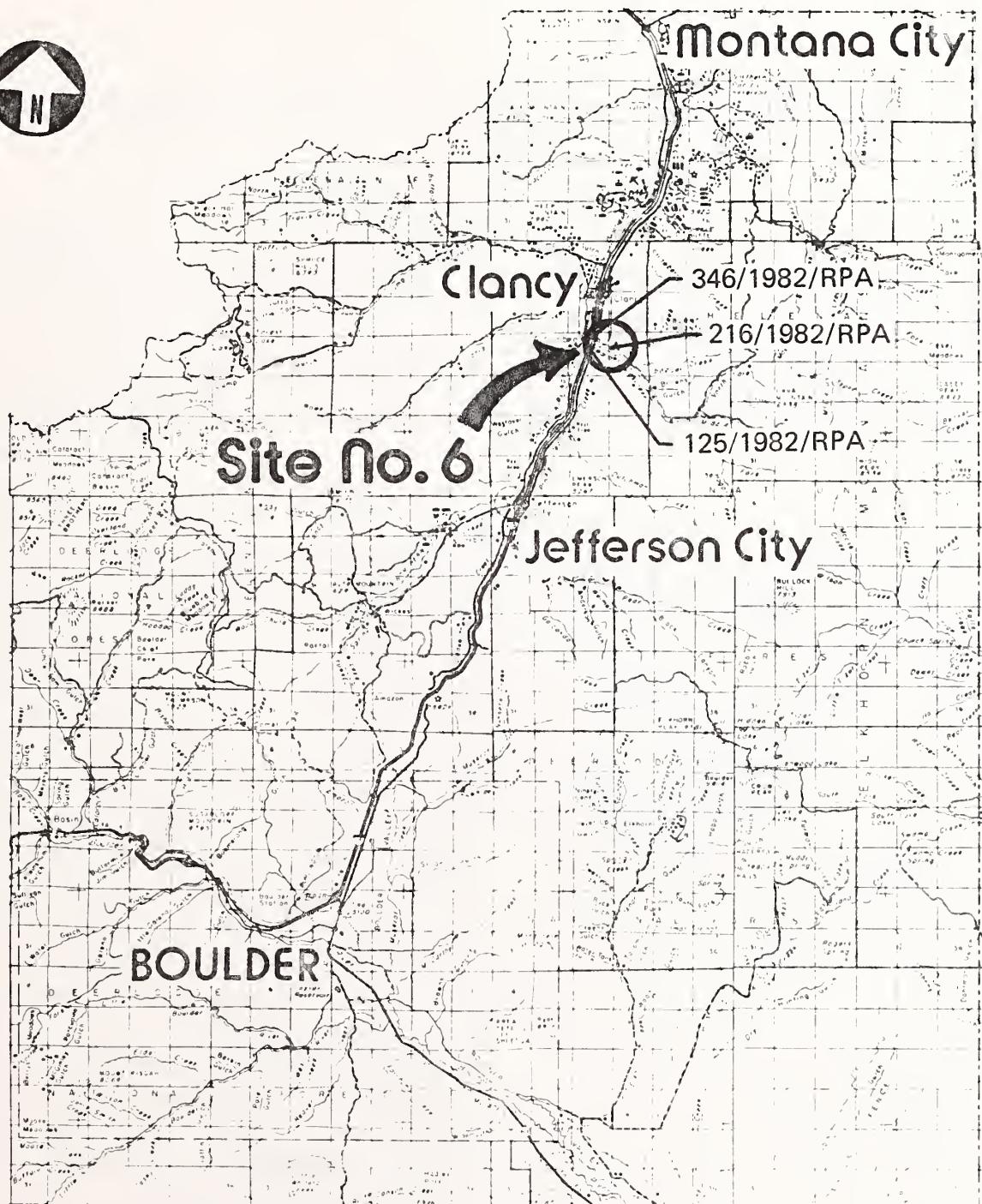
LONG TERM IMPROVEMENT

Cut Back Rock Embankment



LONG TERM IMPROVEMENT

Widen Roadway Surface to a Minimum Width of 22 Feet



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
WARM SPRINGS CREEK ROAD

Figure No.
6-A
Jefferson Co.

SITE #6

INTERSECTION OF FRONTAGE ROAD & WARM SPRINGS CREEK ROAD

A. Location

Site #6 is located approximately 1.2 miles south of Clancy at the intersection of the I-15 Frontage Road and Warm Springs Creek Road. The site consists of a "Tee" intersection and each of its approaches. The Hillbrook Nursing Home facility is located south of the intersection. The location of this site and traffic count data for each leg of the intersection are presented in Figure 6A.

B. Existing Conditions

The I-15 Frontage Road at Site #6 has an asphalt pavement surface that is typically 24 feet wide, and is in generally good condition. Yellow center-line striping delineates two 12-foot driving lanes and restricts passing movements through most of the site. Road grades on the Frontage Road range from 1.6 percent on the south approach to 0.5 percent on the north approach. Warm Springs Creek Road intersects the Frontage Road in the midst of a broad, sweeping curve. The superelevation through this curve ranges from 7.5 to 8.8 percent. Minimum sight distance at the site occurs on the north approach, and is approximately 650 feet at this point.

The Warm Springs Creek Road is a gravel surfaced roadway that is typically 22 feet wide. Road grades on this leg of the intersection are relatively flat, and average less than 1.0 percent in the vicinity of the intersection. Numerous roadside obstructions are within five feet of the roadway edge on the east approach to the intersection.

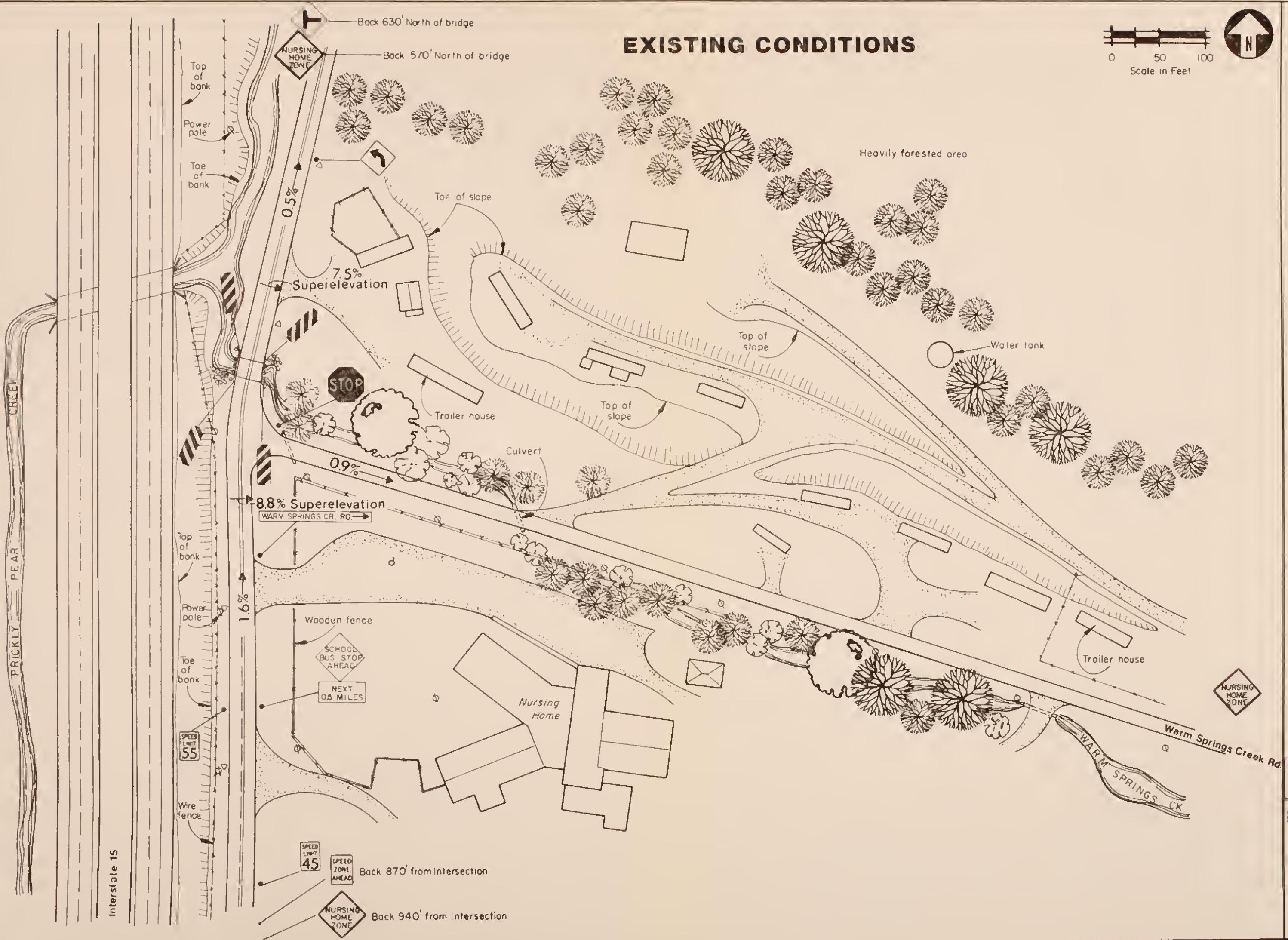
Signing on the south approach to the intersection consists of a non-standard "Nursing Home Zone" sign and a "Speed Zone Ahead" sign (R2-5c) located approximately 900 feet south of the intersection; a "Speed Limit 45" sign (R2-1) with a supplemental mileage plate (W7-3a) located approximately 275 feet from the intersection. Signing on the north approach to the intersection begins approximately 0.5 miles north of the intersection with advance signing for the school bus stop. A "Side Road" sign (W2-2) is located about 650 feet north of the intersection, and a non-standard "Nursing Home Zone" sign is located about 600 feet from the intersection. The bridge on the Frontage Road that spans Warm Springs Creek has object markers (OM-3) that effectively identify the bridge ends for approaching motorists. Traffic on Warm Springs Creek Road is regulated by a stop sign located at the intersection; however, roadside vegetation obscures this stop sign for motorists approaching on this leg of the intersection. Existing conditions at this site are depicted in the site sketch (Figure 6B) and in site photographs (Plate 6) that accompany this analysis.

FRONTAGE ROAD AT WARM SPRINGS CREEK ROAD

Site No. 6

Figure No.
6-B
Jefferson Co

EXISTING CONDITIONS



Existing Site Conditions



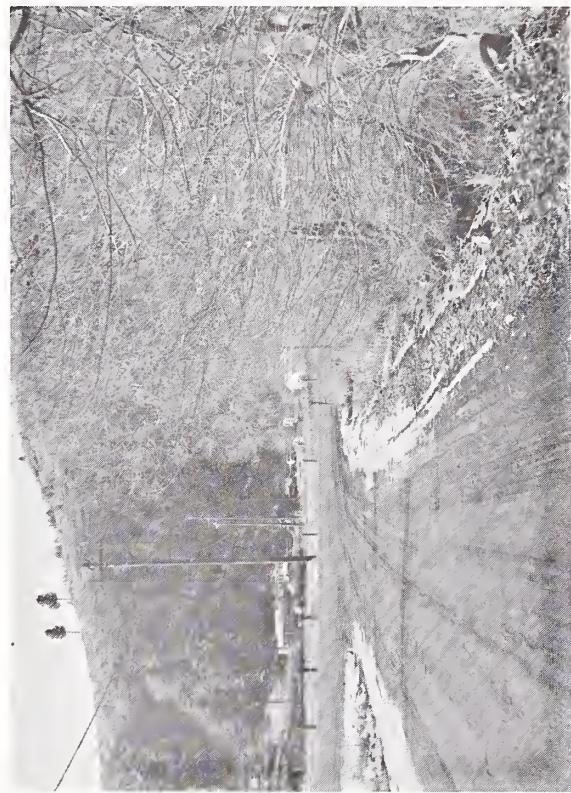
View of the south approach to the intersection. Note the advance warning and the pavement markings.



View of east approach to the intersection along Warm Springs Creek Road.



View of the north approach to the intersection. Note the advance intersection warning signs.



View of east approach to the intersection. Roadside vegetation tends to hide the stop sign from approaching motorists.

Counts of 24-hour traffic volumes were collected for all three legs of the intersection by Robert Peccia & Associates during November, 1982. This data was utilized to determine the average daily traffic (ADT) for this site. Based on this data, it was determined that the ADT on the Frontage Road was 125 vehicles south of the intersection and 346 vehicles north of the intersection. Traffic on the Warm Springs Creek Road was determined to be 216 vehicles.

C. Accident History

A total of three accidents were reported at this site during the four-year study period. One of these accidents resulted in injuries to the driver of the vehicle and one passenger. All three accidents involved single vehicles which left the roadway after the drivers lost control. In two cases, the vehicles struck fixed objects off the roadway edge. Two of the three accidents occurred during the day, and all were during periods of clear weather. Only one accident may be attributed to icy road conditions within the site. The major contributing factors to the accidents at this site were listed as drinking and excessive speed for road conditions. Alcohol was involved in two of the three accidents at this site. The composite collision diagram for Site #6 is depicted in Figure 6C.

The accident rate for this site is 4.5 accidents per million vehicles entering.

D. Recommendations

The intersection of the I-15 Frontage Road and the Warm Springs Creek Road has several problems. Approaching traffic from the east cannot see the stop sign at the intersection because of the overhanging trees adjacent to the road. In addition, the road surface in the vicinity of the intersection on the Warm Springs Creek Road is often full of potholes or has a "washboard" surface, making it difficult for drivers to maintain control of their vehicles. The short-term improvements outlined below address these problems and the lack of appropriate signing at this site.

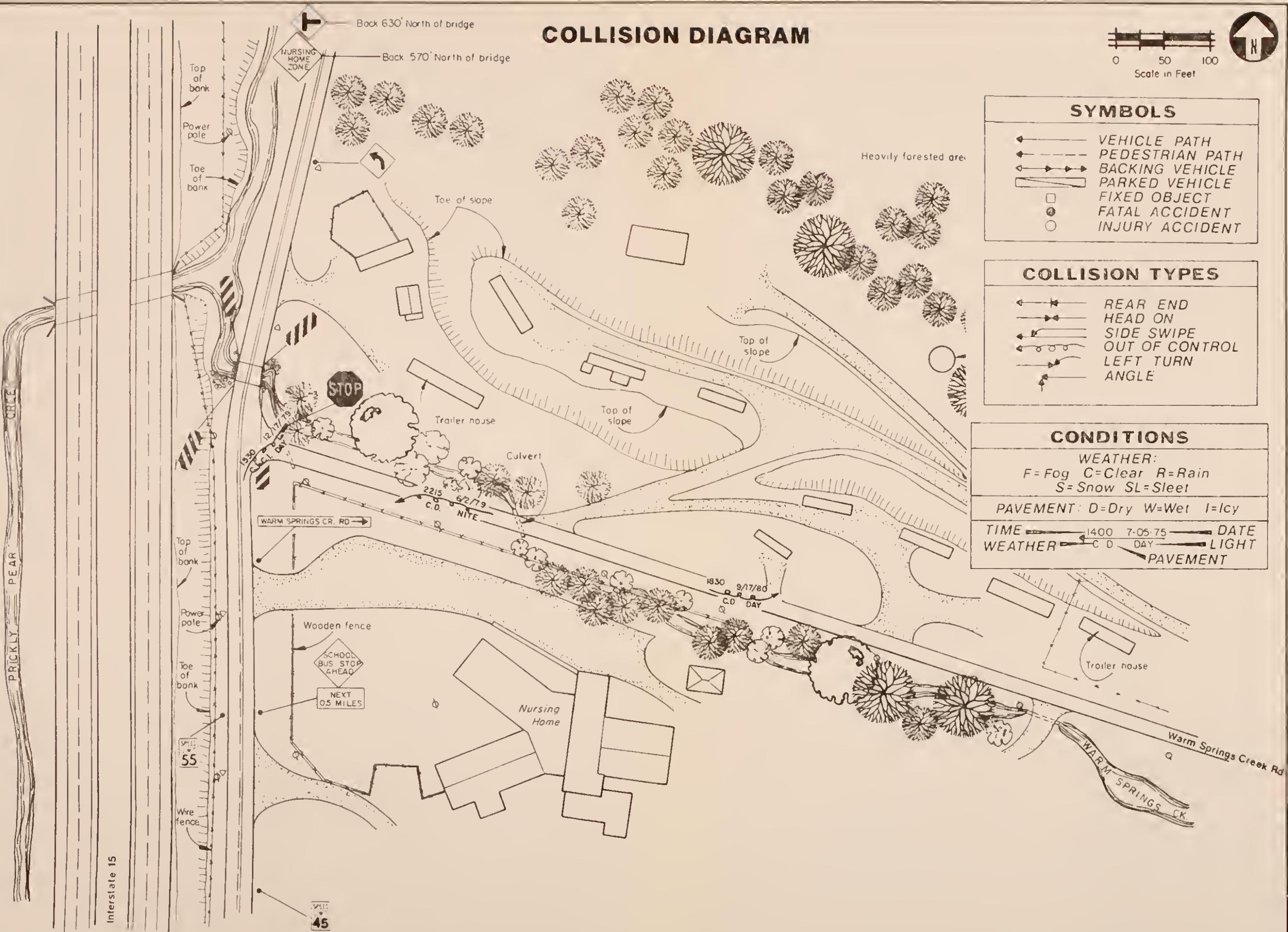
1. The overhanging tree branches and several small trees on the north side of the Warm Springs Creek Road obscure the stop sign until motorists are within 100 feet of the intersection. It is recommended that this vegetation be pruned back on an annual basis to provide a clear view of the stop sign from 500 feet back on the east approach.
2. The intersection warning signing at this site should be upgraded to provide motorists with ample time to react to the upcoming situation. The intersection warning sign presently being used on the north approach is a "Tee" intersection sign (W2-4) mounted sideways to simulate a side road warning sign. It is recommended that this existing sign be removed and the more appropriate side road warning sign (W2-2) be installed. The present setback distance of 630 feet is adequate, and the new sign can be installed on the existing post. A similar side road warning sign (W2-2) should also be installed on the south approach 750 feet back from the intersection. In addi-

FRONTAGE ROAD AT WARM SPRINGS CREEK ROAD

site no. 6

Figure No.
6-C
Jefferson Co.

COLLISION DIAGRAM



ACCIDENT DATA

Intersection of Frontage Road and Warm Springs Creek Road

SITE NUMBER 6

ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
	2	1	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1			1		1

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					1			1			1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
															1		1			1			

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
2	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
2			1	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
3			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swi-pe	Non-Col	Head-on	Backing
			2				1		

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1	1		1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury			1	
Fatality				
Property Dam. Only		2		

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

2

tion, a stop ahead sign (W3-1) should be installed 500 feet east of the intersection on Warm Springs Creek Road.

3. To further identify the intersection, a large double directional arrow (W1-7, 48" x 24") should be installed on the west side of the intersection. The arrow should be located so that it is clearly visible to approach traffic from 500 feet back on the east approach. To identify the location of the side road entrance, two reflectorized delineators (Design D, 4" x 8", amber, bi-directional) should be installed; one on each side of the Warm Springs Creek road at the entrance. These reflectors should be located so that they can be seen on the Frontage Road from both approaches.

4. The existing stop sign is undersized for the road conditions at this site. It should be removed and replaced with a larger (36" x 36") sign, which is considered standard for rural areas.

5. The roadway narrows at the culvert that crosses under the Warm Springs Creek Road approximately 275 feet east of the intersection, and steep shoulders drop off adjacent to the roadway into the creek. This situation should be identified by installing two object markers (OM-3) back-to-back on the same pole on both sides of the road. This will help to alert motorists of the roadside hazard.

6. The "Nursing Home Zone" signs located on all three approaches to the intersection at this site are not generally used in the state. However, the Manual on Uniform Traffic Control Devices agrees that non-standard warning signs may be used under certain special conditions. The existing signs are of the proper size, shape and color and are properly located. In this particular instance, these signs are intended to alert motorists to the possible presence of elderly residents of the Hillbrook Nursing Home, who often walk along the edge of the road, since there are no walks or paths available. Because of this special situation, these non-standard warning signs are appropriate. However, it should be noted that the overuse of non-standard signs may tend to confuse motorists and may distract attention away from the very hazard they are trying to identify. Therefore, this signing practice should be kept to an absolute minimum.

7. The condition of the Warm Springs Creek Road presents a major problem to motorists. During the field inspection, drivers were observed swerving around potholes, especially on the immediate intersection approach. The gravel surface of this road should be periodically graded smooth to minimize the washboard surface and potholes. During the winter months, sanding should be performed to minimize icy and snow-packed road conditions.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Remove Trees & Cut Back Branches	-	\$300
1	ea	Remove "T" Intersection Sign	\$35	35
2	ea	Install Side Road Warning Sign (W2-2)	\$130	260
1	ea	Install Stop Ahead Warning Sign (W3-1)	\$130	130
1	ea	Install Large Double Directional Arrow (W1-7, 48" x 24")	\$163	163
2	ea	Install Reflectorized Delineators (Design D, 4" x 8", amber, bi-directional)	\$28	56
1	ea	Remove Existing Stop Sign	\$35	35
1	ea	Install Oversized Stop Sign (R1-1, 36" x 36")	\$105	105
4	ea	Install Object Makers (OM-3)	\$130	<u>520</u>
Total Cost:				\$1,604
Benefit/Cost Ratio: 1.6				

Long-Term Improvements

The roadway narrows to approximately 20 feet at the culvert crossing on the Warm Springs Creek Road. In addition, the shoulders of the road have eroded away, and presently drop off almost vertically into the creek. This situation should be corrected by installing concrete headwalls and wingwalls on both ends of the culvert. In this way, the roadway width can be uniformly maintained at 24 feet. The head- and wingwalls will also improve the flow characteristics of the creek and will actually increase the capacity of the existing culverts.

The creek parallels the Warm Springs Creek Road along the intersection approach, and the shoulder of the road on the north side of the intersection drops off sharply into the creek. In addition, a six-inch-diameter gas pipeline crosses over the creek adjacent to the intersection, and presents a severe hazard in the event of an accident. It is recommended that guard rail be installed along the north side of the Warm Springs Creek Road beginning at the bridge crossing on the Frontage Road and extending around the corner, down the north side of the east approach, and over the culvert crossing. In this way, drivers will be protected from the sharp dropoff during icy and snowy road conditions.

LONG-TERM IMPROVEMENT COST ESTIMATE

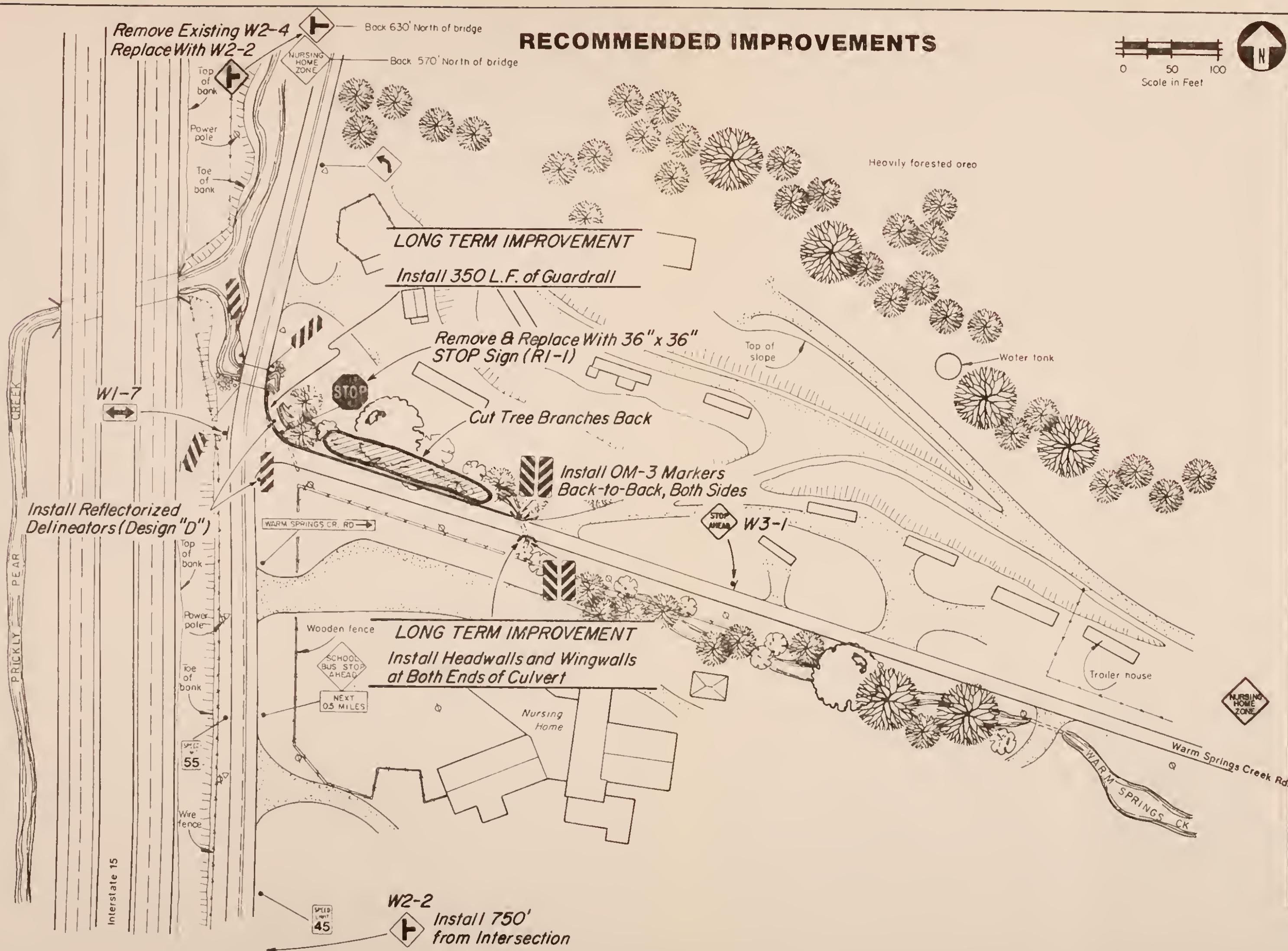
Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Install Headwalls and Wingwalls on Both Sides of Culvert Crossing	-	\$7,000
350	lf	Install Guard Rail	\$9	<u>3,150</u>
Total Cost:				\$10,150

FRONTAGE ROAD AT WARM SPRINGS CREEK ROAD

Site No. 6

Figure No.
6-D
Jefferson Co.

RECOMMENDED IMPROVEMENTS



DETERMINATION OF HAZARD INDEX

Site Number 6 Date December, 1982

Site Description Intersection of Frontage Road and Warm Springs Creek Road

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	<u>.75</u>	acc/yr	<u>22</u>	x 0.164 = <u>3.61</u>
Accident Rate	<u>4.5</u>	acc/MVE	<u>63</u>	x 0.225 = <u>14.18</u>
Accident Severity	<u>11,100</u>	dollars	<u>67</u>	x 0.191 = <u>12.80</u>
Volume/Capacity Ratio	<u>.24</u>		<u>41</u>	x 0.082 = <u>3.36</u>
Sight Distance Ratio	<u>.95</u>	(wt. avg.)	<u>36</u>	x 0.074 = <u>2.66</u>
Driver Expectancy	<u>3.7</u>	(wt. avg.)	<u>62</u>	x 0.149 = <u>9.24</u>
Information System Deficiencies	<u>3.3</u>	(wt. avg.)	<u>55</u>	x 0.115 = <u>6.33</u>

Hazard Index: 52.18

Cost of Recommended Improvements: \$1,604

Cost Factor: 96

Priority Index = Hazard Index x .75 + Cost Factor x .25

52.18 x .75 + 96 x .25 = 63.14



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
WARM SPRINGS CREEK ROAD

Figure No.
7-A
Jefferson Co.

SITE #7

WARM SPRINGS CREEK ROAD AT RATTLESNAKE CREEK

A. Location

Site #7 is located on Warm Springs Creek Road approximately 0.7 miles east of the I-15 Frontage Road at Alhambra. This site consists of a series of curves through the rolling terrain adjacent to Warm Springs Creek. Land in the area is primarily used as livestock pasture or for scattered residential development. The location of this site and the traffic count data for Warm Springs Creek Road are presented in Figure 7A.

B. Existing Conditions

The Warm Springs Creek Road at Site #7 is typically 20 feet wide with a roadway surface of decomposed granite. The general condition of the roadway within the site is fair; however, vehicles must travel over a rough, "washboard" surface when traveling up grades within the site. Road grades through the rolling terrain at the site range from a minimum of 1.0 to a maximum of 5.1 percent in the western portion of the site. Superelevations through most of the curves are effective; however, the superelevations in the first series of curves in the eastern portion of the site vary considerably and vehicle movement, particularly for westbound motorists, is hindered. Westbound motorists must travel first through a curve with a steep superelevation of 9.2 percent and then travel up a 2.9-percent grade into a reverse curve. The superelevation in this curve is 1.6 toward the outside, and presents a particularly hazardous situation in which westbound vehicles are forced toward the outside of the curve. The changes in roadway alignment and the terrain in the area limit sight distance to 110 feet in several locations within the site. In addition to the lack of adequate sight distance through portions of the site, a large rock outcrop near the western end of the site and steep areas adjacent to the roadway also constitute hazardous situations for unwary motorists. No signing presently exists within the site to warn drivers of these hazards. The existing conditions at Site #7 are depicted in Figure 7B and in Plate 7.

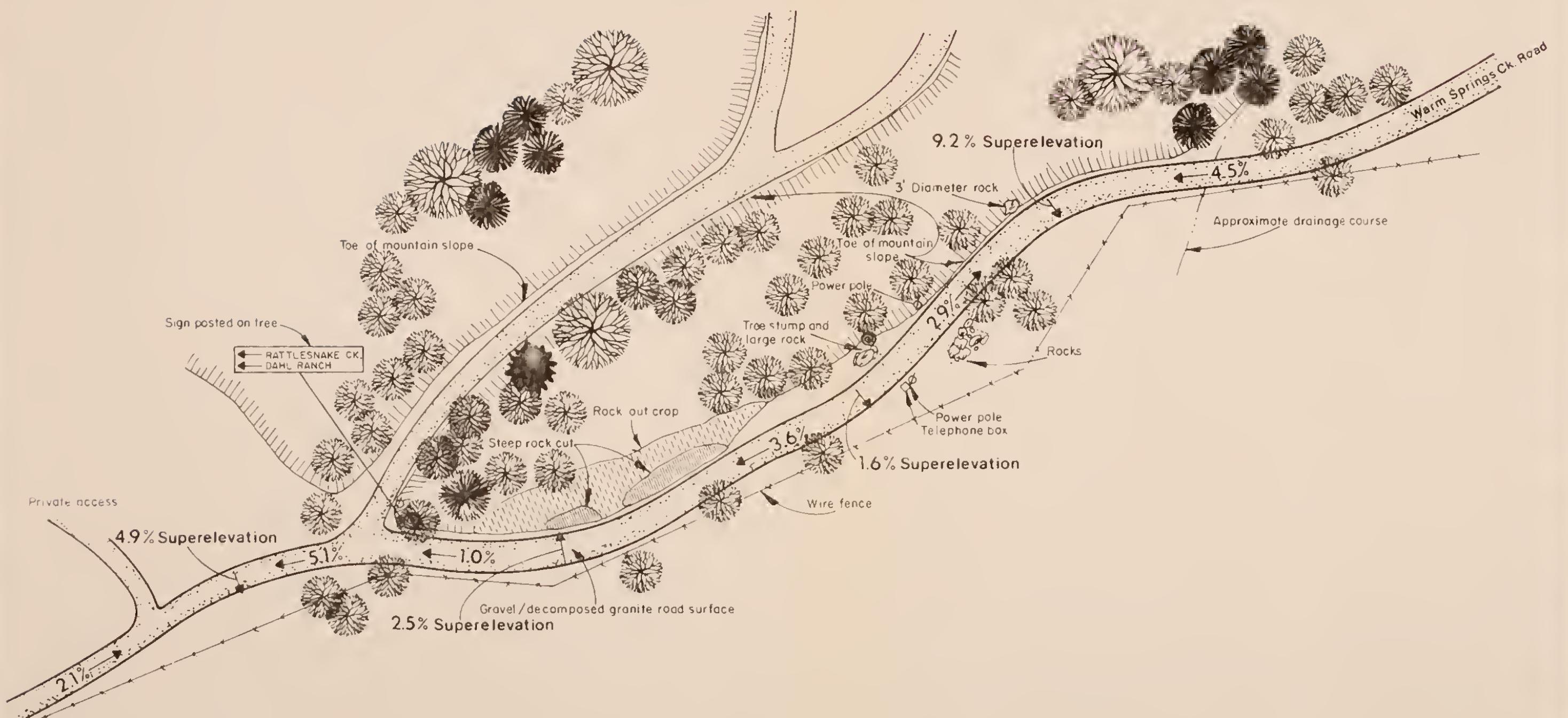
Counts of 24-hour traffic volumes were collected for Warm Springs Creek Road by Robert Peccia & Associates during November, 1982. Based on this data, it was determined that the average daily traffic at this location was 216 vehicles.

C. Accident History

A total of five accidents were reported at Site #7 during the four-year study period. None of the accidents resulted in injuries or fatalities. Three of the accidents were two-vehicle sideswipe collisions, and two were fixed-object collisions in which vehicles left the roadway and struck stationary ob-

EXISTING CONDITIONS

0 50 100
Scale in Feet



Site No. 7

Figure No.
7-B
Jefferson Co.

WARM SPRINGS CREEK
ROAD-RATTLESNAKE CREEK

Existing Site Conditions



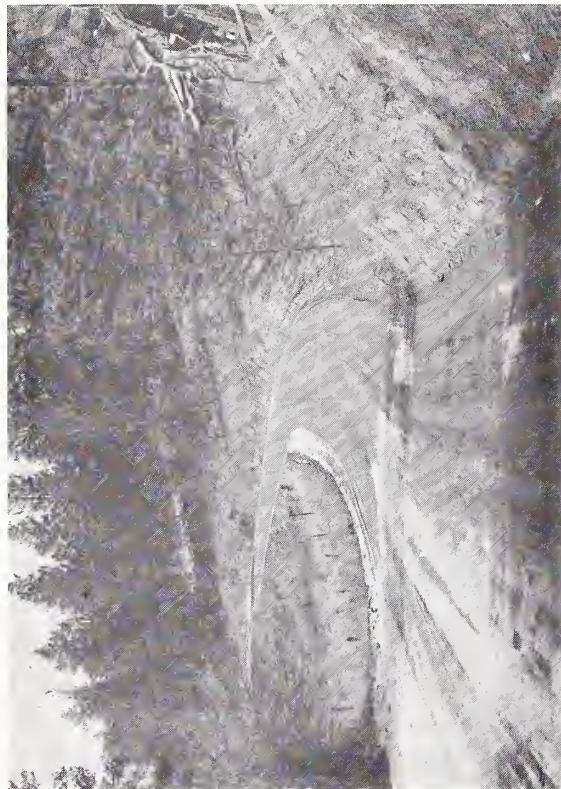
View of the Warm Springs Creek Road near the western edge of Site 7.



An example of sight distance limitations caused by an abrupt change in road grade. This area is located about midway through the site.



View of the rock outcrop and change in roadway alignment near the western edge of the site that limit sight distance to 110 feet.

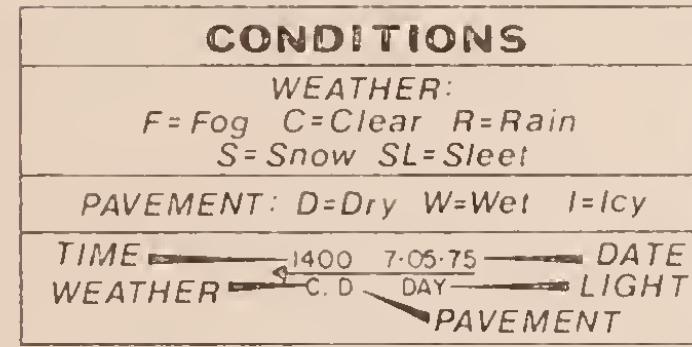
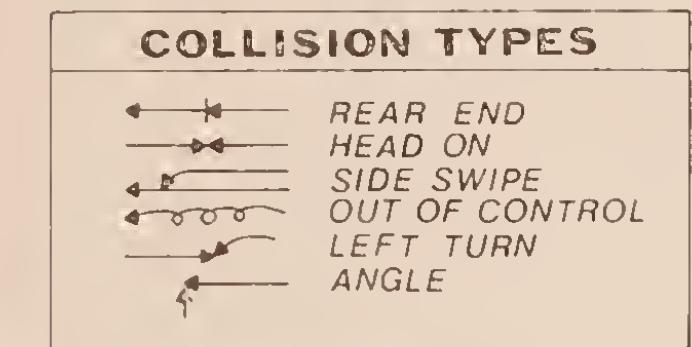
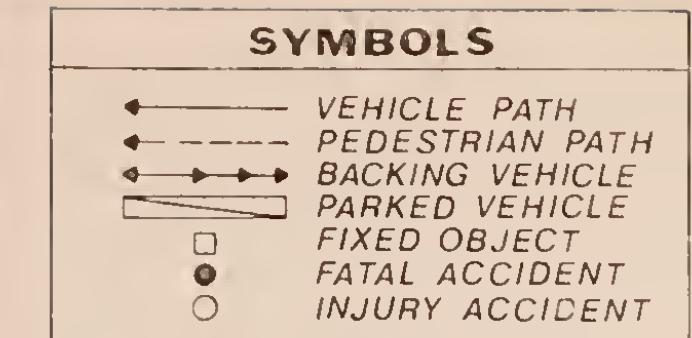


View of the eastern approach to the site. Note steep areas adjacent to the roadway.

WARM SPRINGS CREEK ROAD-RATTLESNAKE CREEK

Site no. 7

Figure No.
7-C
Jefferson Co.



ACCIDENT DATA

Warm Springs Creek Road at Rattlesnake Creek

SITE NUMBER 7

ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
2	1		2

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
1			2	1	1	

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2	1								1		1

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
															1	1	1	1					1

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
4	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
1			4	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
2		3	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			2			3			

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
3			1					1

NUMBER OF ACCIDENTS BY SEVERITY

Injury	1978	1979	1980	1981
Fatality				
Property Dam. Only	2	1		2

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

0

jects adjacent to the roadway. Four of the five accidents occurred during the winter, and most occurred during daylight hours. Nearly all of the reported accidents occurred during icy road conditions. Due to the surrounding terrain and the thick roadside vegetation along much of this site, built-up snow and ice on the roadway seldom melts off during the day. The major contributing circumstances to the reported accidents at this site appear to be a lack of adequate sight distance and excess speed for road conditions. Alcohol was not involved in any of the reported accidents at the site. The composite collision diagram for Site #7 is depicted in Figure 7C.

The accident rate for this site is 15.9 accidents per million vehicles entering.

D. Recommendations

The sharp changes in the roadway alignment at this site limit the sight distance, and there is no signing or delineation at this location to aid the motorist. The short-term improvements outlined below concentrate on providing the appropriate signing system needed to safely guide motorists through this site. The long-term improvements address the problem of limited sight distance.

1. A vehicle equipped with a ball bank indicator was used to determine that 20 mph is the maximum safe speed for the curves at this site. It is recommended that winding road warning signs (W1-5) with supplemental 20 mph advisory speed plates be installed on both approaches to this site. The signs should be located approximately 350 feet in advance of the first curve on each approach.
2. To help motorists define the roadway alignment through the site, a series of reflectorized delineators (Design C, 4" x 4", silver, bi-directional) should be installed along the outside of the curves and should be spaced as shown in Figure 7D. These reflectors will also help County snowplow crews to identify the edge of the road so that they can plow the maximum width.
3. Four of the five accidents at this site occurred during icy road conditions. Given the narrow, winding nature of this site, it is recommended that County crews plow and sand this section on a regular basis during the winter months. This maintenance program should help drivers negotiate this very difficult site.
4. The superelevation of two curves at this site are too flat or sloped the wrong way. These incorrect superelevations pose serious problems, and could easily throw vehicles toward the outside of the curves and off the road. Therefore, it is recommended that these curves be reconstructed to provide proper superelevations. A uniform cross grade of 6 percent is required in the western curve, and 4 percent in the eastern curve (see Figure 7D).

DETERMINATION OF HAZARD INDEX

Site Number 7 Date December, 1982

Site Description Warm Springs Creek Road at Rattlesnake Creek

Indicator	Data Value	Indicator		
		Value	Weight	Partial H.I.'s
Number of Accidents	<u>1.25</u> acc/yr	<u>30</u>	x 0.164	= <u>4.92</u>
Accident Rate	<u>15.9</u> acc/MVE	<u>100</u>	x 0.225	= <u>22.50</u>
Accident Severity	<u>16,080</u> dollars	<u>78</u>	x 0.191	= <u>14.90</u>
Volume/Capacity Ratio	<u>.27</u>	<u>44</u>	x 0.082	= <u>3.61</u>
Sight Distance Ratio	<u>.37</u> (wt. avg.)	<u>100</u>	x 0.074	= <u>7.40</u>
Driver Expectancy	<u>4.8</u> (wt. avg.)	<u>80</u>	x 0.149	= <u>11.92</u>
Information System Deficiencies	<u>6.0</u> (wt. avg.)	<u>100</u>	x 0.115	= <u>11.50</u>

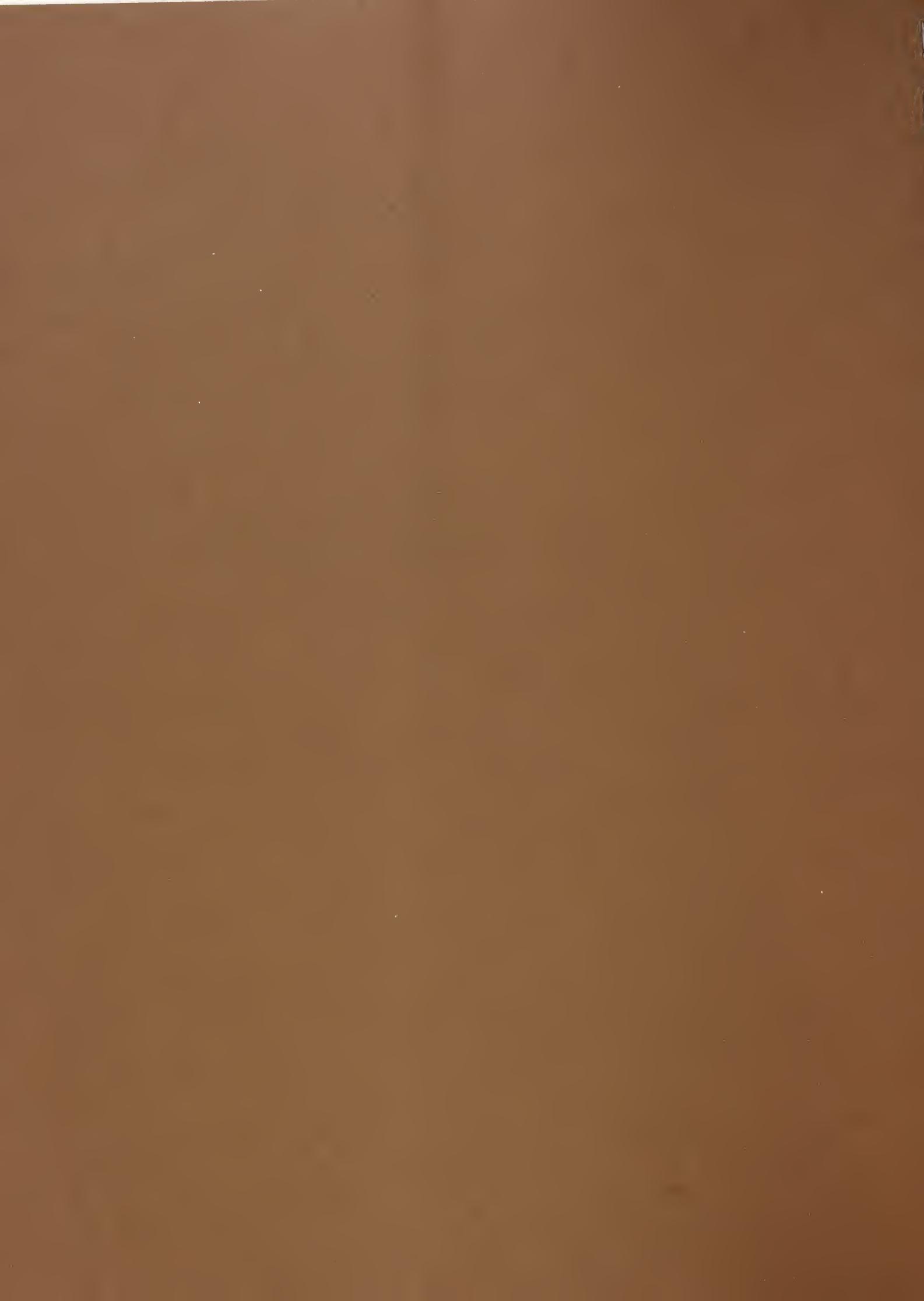
Hazard Index: 76.75

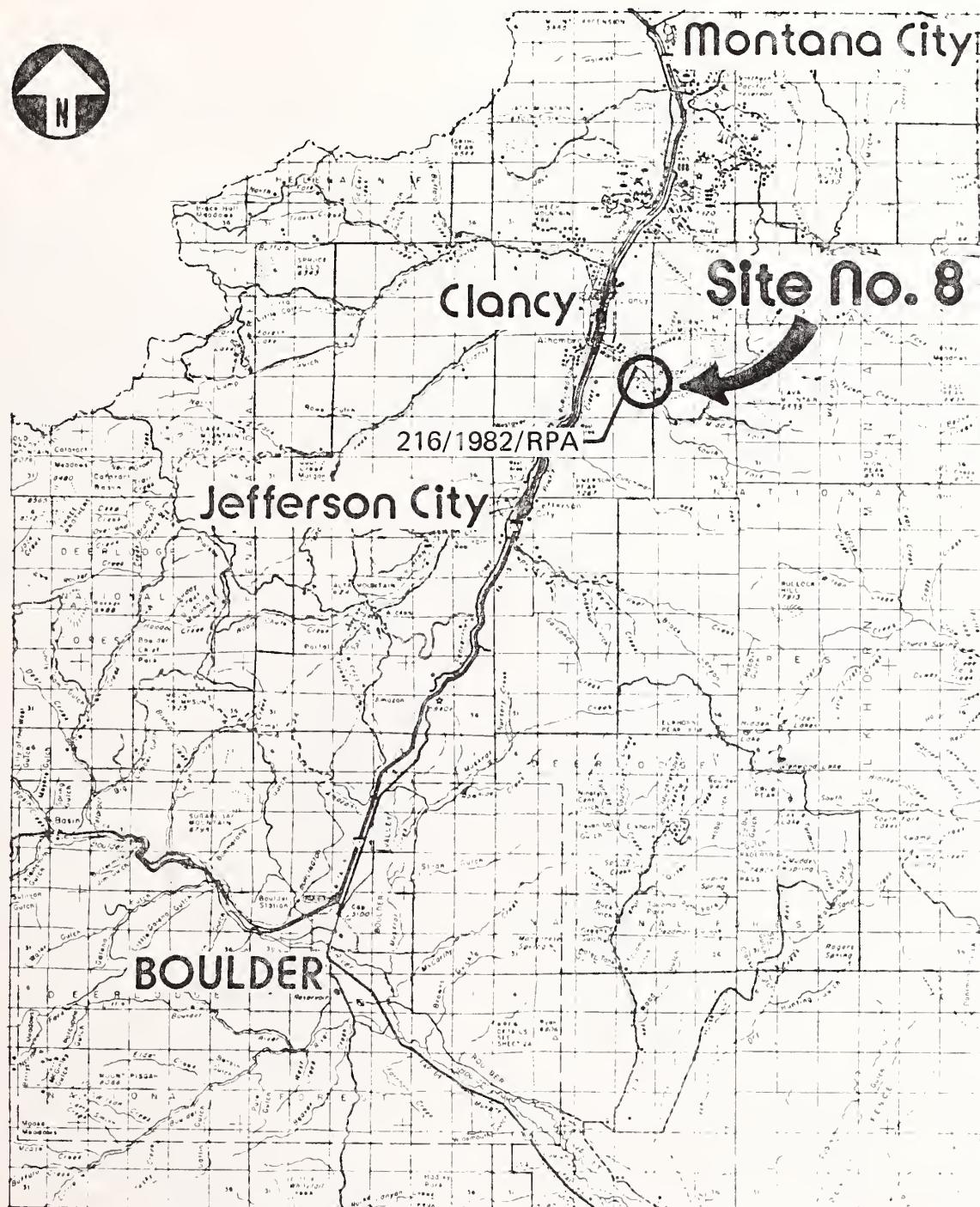
Cost of Recommended Improvements: \$1,628

Cost Factor: 92

Priority Index = Hazard Index x .75 + Cost Factor x .25

76.75 x .75 + 92 x .25 = 80.56





Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
WARM SPRINGS CREEK ROAD

Figure No.
8-A
Jefferson Co.

SITE #8

WARM SPRINGS CREEK ROAD AT BADGER CREEK

A. Location

Site #8 is located on Warm Springs Creek Road approximately 1.1 miles east of its intersection with the I-15 Frontage Road at Alhambra. The site is located in rolling terrain and consists of a blind hill located within a broad curve. Land in the area is primarily used for agricultural purposes; however, scattered residential development is located just east of the site. The location of this site and traffic count data for Warm Springs Creek Road is presented in Figure 8A.

B. Existing Conditions

Warm Springs Creek Road at Site #8 has a decomposed granite roadway surface that ranges in width from 17 to 20 feet. The roadway surface at this location is in fair condition; however, the roadway has a "washboard" surface in several locations. Road grades within the site range from a minimum of 1.5 percent to a maximum of 9.8 percent. These grades occur at opposite approaches to the same hill, and result in severe sight distance limitations. Improper superelevations compound the problem at this location and present motorists with an extremely dangerous driving situation. Ineffective superelevations, which have a tendency to force vehicles to the outside, occur at several other locations within the broad curve at the site. Sight distance at the abrupt grade change is limited to approximately 120 feet. Roadside obstructions and steep shoulder areas adjacent to the roadway also constitute hazardous driving conditions within the site. A large tree at the edge of the roadway limits the width of the travelway to 17 feet midway through the site. Currently, no signing exists within the section of the Warm Springs Creek Road. Existing site conditions are depicted in the site sketch (Figure 8B and the site photographs (Plate 8) accompanying this analysis.

Twenty-four-hour machine counts of traffic volumes on Warm Springs Creek Road were collected by Robert Peccia & Associates during November, 1982. Based on this data, it was determined that the average daily traffic (ADT) at this site is 216 vehicles.

C. Accident History

A total of four accidents were reported at this site during the four-year accident study period. No injuries or fatalities resulted from these accidents. Three head-on collisions and one single-vehicle fixed-object collision were reported. All three head-on collisions occurred during snow-packed or icy road conditions. Only one accident occurred at night. This section of Warm Springs Road is similar to that described in the Site #7 analysis, since roadside vegetation does not allow snow and ice to melt. In addition to ad-

EXISTING CONDITIONS

0 50 100
Scale in Feet



WARM SPRINGS CREEK
ROAD. BADGER CREEK

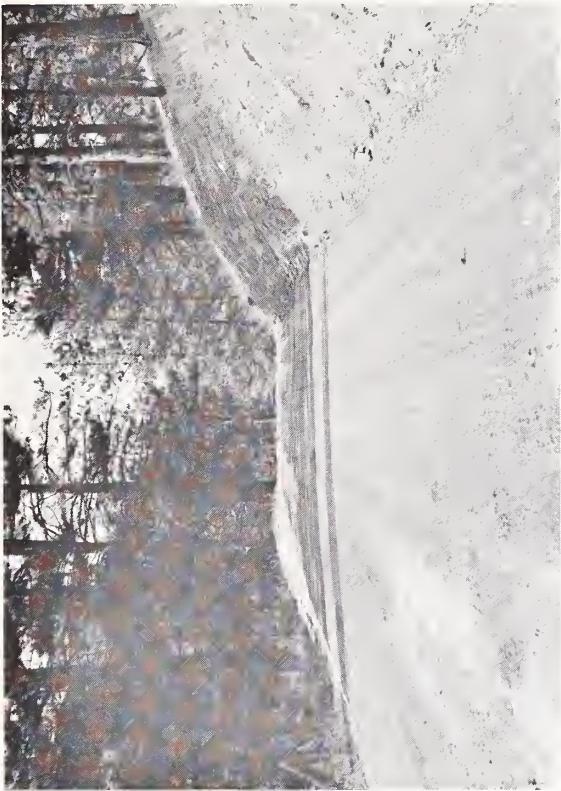
Site No. 8

Figure No.
8-B
Jefferson Co

Existing Site Conditions



View of the western approach to Site 8. Note the heavy roadside vegetation and the steep areas adjacent to the roadway.



View of the eastern approach to the abrupt grade change. Sight distance is limited to approximately 115 feet by the change in grade.



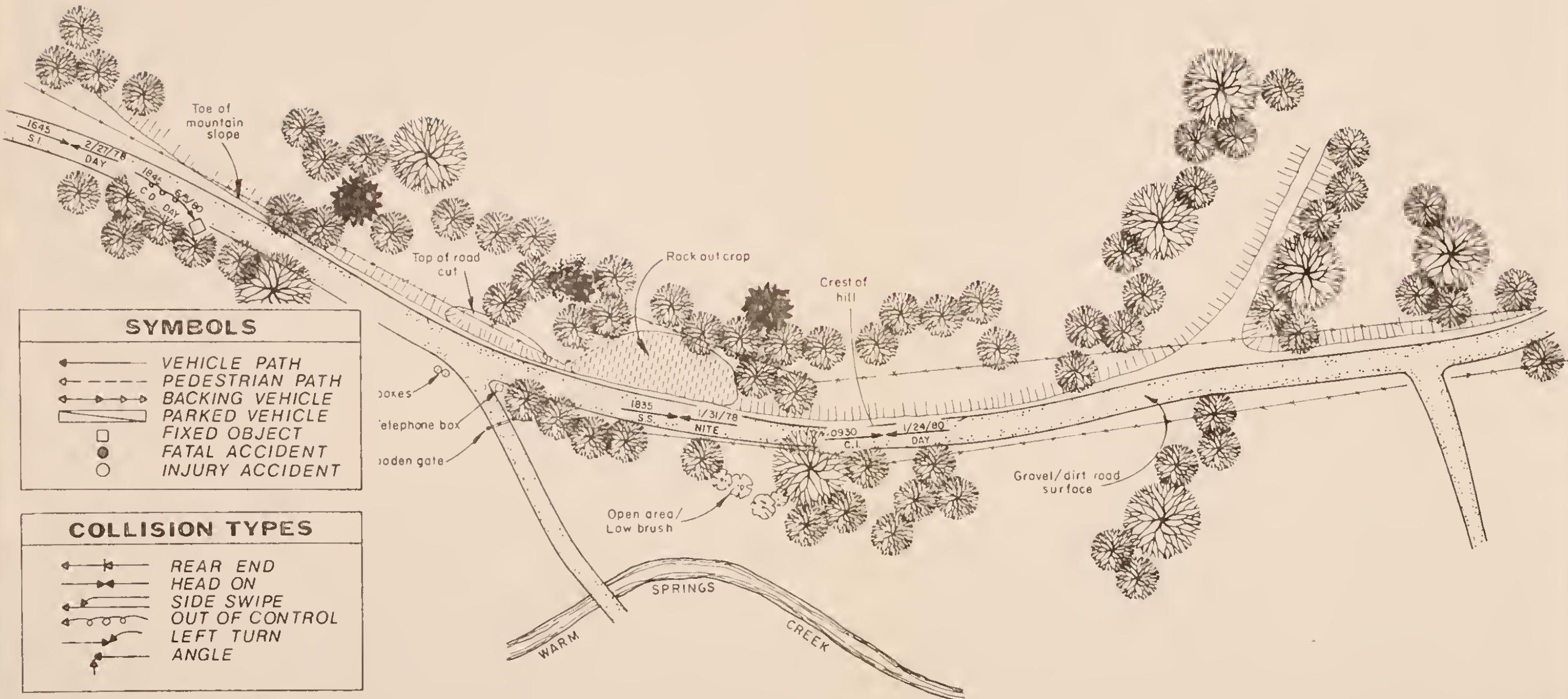
View of the western approach to the abrupt grade change midway through the site. The grade is approximately 9.8 percent at this location.



View of terrain typical to this section of the Warm Springs Creek Road.

COLLISION DIAGRAM

0 50 100
Scale in Feet



WARM SPRINGS CREEK
ROAD-BADGER CREEK

Site no. 8

Figure No.
8-C
Jefferson Co

ACCIDENT DATA

Warm Springs Creek Road at Badger Creek

SITE NUMBER 8

ACCIDENT PERIOD 1978 - 1981

NUMBER OF ACCIDENTS BY YEAR

1978	1979	1980	1981
2		2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
	1	1			2	

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
2	1				1						

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
								1							1		2						

NUMBER OF ACCIDENTS BY LIGHT CONDITIONS

Day-light	Dark	Dawn	Dusk
3	1		

NUMBER OF ACCIDENTS BY ROAD CONDITIONS

Dry	Wet	Snow	Ice	Other
1		1	2	

NUMBER OF ACCIDENTS BY WEATHER CONDITIONS

Clear	Rain	Snow	Fog
2		2	

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swi-pe	Non-Col	Head-on	Backing
			1						3

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
3			1					

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury				
Fatality				
Property Dam. Only	2		2	

NUMBER OF ACCIDENTS ALCOHOL INVOLVED

1

verse road or weather conditions, sight distance limitations and excess speed for road conditions appear to be the primary contributing circumstances to the accidents that were reported at Site #8. Alcohol was involved in one of the four accidents. The composite collision diagram for the accidents at this site is depicted in Figure 8C.

The accident rate for this section of the Warm Springs Creek Road is 12.7 accidents per million vehicles entering.

D. Recommendations

This site has several problems, including narrow roadway width, steep grade, and poor superelevations. The short-term improvements deal with delineating this section of road and correcting the superelevations, while the long-term improvements address the lack of adequate roadway width. The short-term improvements are as follows:

1. A series of reflectorized delineators (Design C, 4" x 4", silver, bi-directional) should be installed to mark the roadway alignment. These reflectors should be located on the south side of the road and should be equally spaced at 100 feet apart. Due to the long sloping curve at this site, no variation in delineator spacing is required. These reflectors will help motorists to identify the change in alignment as well as aiding maintenance crews in determining the exact edge of the roadway so that the entire width of the road can be plowed.
2. The superelevation of the long curve at this site slopes in the wrong direction. The cross grade of the road should be slanted to the inside of a curve to counteract the outside forces on vehicles in the turn. The present superelevation is very dangerous, especially when the road is icy or snow-packed. It is recommended that this curve be reconstructed to provide a maximum superelevation of 4.0 percent sloping to the north side of the road. The cross section of the road should be relatively level on the tangent approaches, and should progressively gain cross slope as it enters the curve. The maximum superelevated grade should be maintained through the curve itself, and should then taper back to a level cross grade in the far approach section. Approximately 1,000 feet of road will require regrading to achieve the desired superelevation. For more information on superelevations, refer to the AASHTO Policy on Geometric Design of Rural Highways.
3. Three of the four accidents reported at this site during the study period were head-on collisions. In addition, three of the four accidents occurred on icy or snow-packed roads. It is recommended that the road maintenance crews plow the maximum roadway width to provide room for vehicles to pass safely in this section. The steep grade and narrow width of the road make this site exceptionally dangerous when snowpacked or icy. It is recommended that sanding of this section of road be increased during the winter to provide the necessary vehicle traction at this site.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
12	ea	Install Reflectorized Delin- eators (Design C, 4" x 4", silver, bi-directional)	\$18	\$ 216
-	Lump Sum	Reconstruct Curve Superelevation to .04 ft/ft	-	<u>1,200</u>
Total Cost:				\$1,416

Benefit/Cost Ratio: 1.4

Long-Term Improvements

Sight distance is severely restricted by the rock and earth embankment on the north side of the road. In addition, the road is narrow at this site, which compounds the difficulty experienced when traveling through this portion of the Warm Springs Creek Road. It is recommended that the toe of the embankment on the inside of the curve on the north side of the road be cut back approximately five feet and the bank sloped back at a 2:1 slope. The excavated material should be deposited at the bottom of the hill and used to flatten the grade. The excavated material should also be deposited along the south side of the road at this site and along other adjacent portions of the Warm Springs Creek Road to provide a wider travelway and flatter shoulder slopes. If this improvement is done, the curve and steep grade at Site #8 will be widened to provide more room for passing vehicles and sight distances will be increased to at least 200 feet. This is considered the minimum desirable distance required for safe stopping at this site.

The abrupt change in grade in the center of the site also limits sight distance. The crest of the hill should be cut down and the vertical curve lengthened to provide the necessary sight distance.

LONG-TERM IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
-	Lump Sum	Excavation & Embankment (2,000 cy)	-	\$16,000

WARM SPRINGS CREEK
ROAD-BADGER CREEK

Site No. 8

Figure No.
8-D
Jefferson Co.

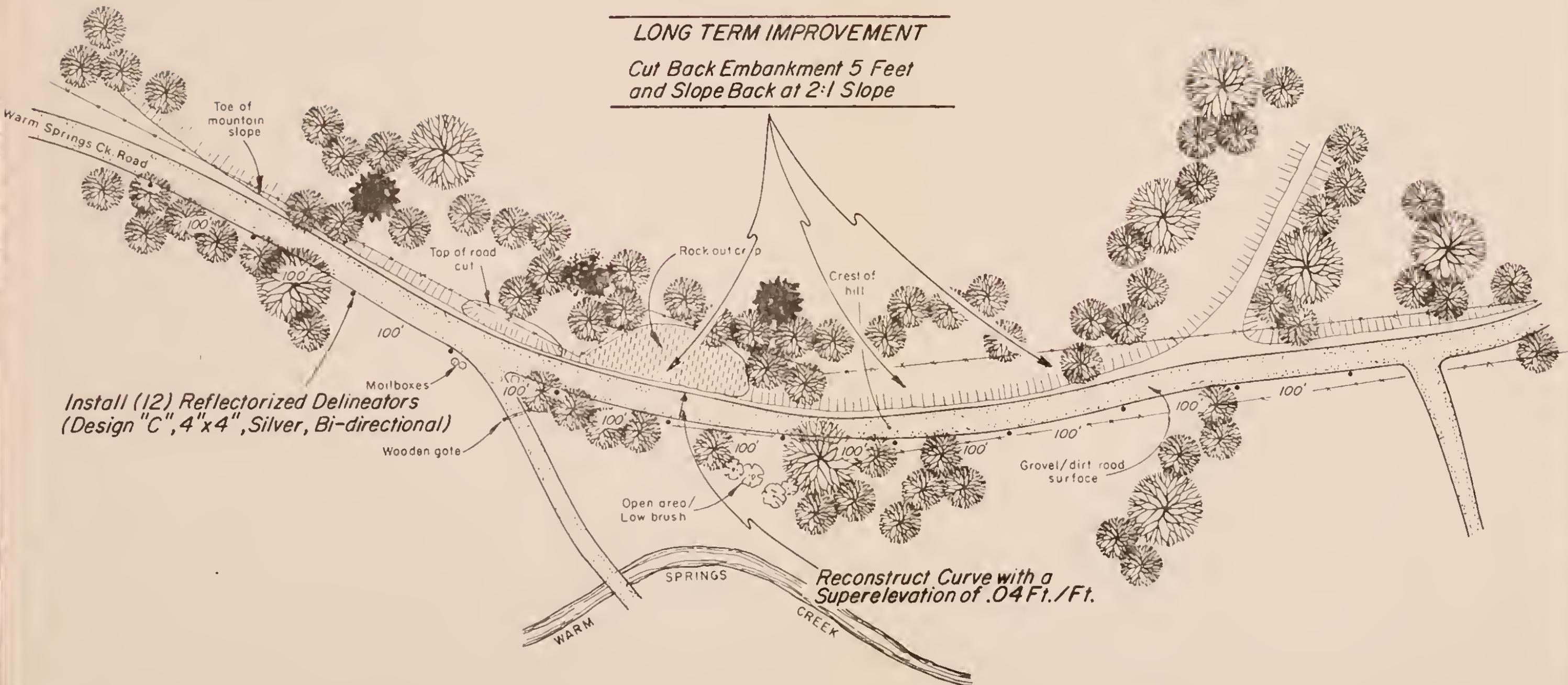
RECOMMENDED IMPROVEMENTS

0 50 100
Scale in Feet



LONG TERM IMPROVEMENT

Cut Back Embankment 5 Feet
and Slope Back at 2:1 Slope



DETERMINATION OF HAZARD INDEX

Site Number 8 Date December, 1982

Site Description Warm Springs Creek Road at Badger Creek

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	<u>1.0</u> acc/yr	<u>26</u>	x 0.164	= <u>4.26</u>
Accident Rate	<u>12.7</u> acc/MVE	<u>100</u>	x 0.225	= <u>22.50</u>
Accident Severity	<u>17,800</u> dollars	<u>81</u>	x 0.191	= <u>15.47</u>
Volume/Capacity Ratio	<u>.30</u>	<u>47</u>	x 0.082	= <u>3.85</u>
Sight Distance Ratio	<u>.39</u> (wt. avg.)	<u>100</u>	x 0.074	= <u>7.40</u>
Driver Expectancy	<u>5.0</u> (wt. avg.)	<u>83</u>	x 0.149	= <u>12.37</u>
Information System Deficiencies	<u>5.5</u> (wt. avg.)	<u>92</u>	x 0.115	= <u>10.58</u>

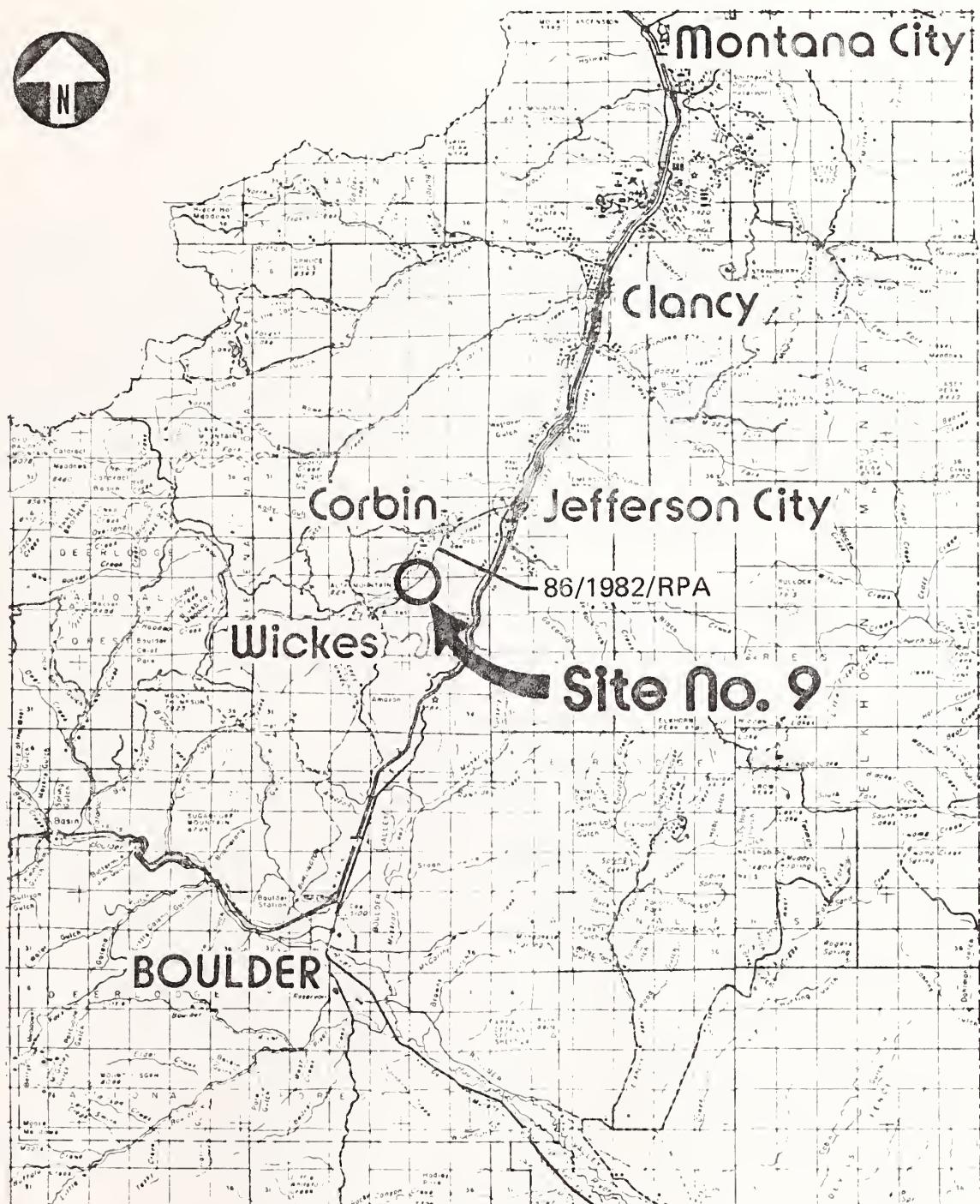
Hazard Index: 76.43

Cost of Recommended Improvements: \$1,416

Cost Factor: 93

Priority Index = Hazard Index x .75 + Cost Factor x .25

76.43 x .75 + 93 x .25 = 80.57



Average Daily Traffic/Year/Source of Count

2,090/1981/MDOH

SITE LOCATION
TRAFFIC COUNTS
WICKES-CORBIN ROAD

Figure No.
9.A
Jefferson Co.

SITE #9

CORBIN - WICKES ROAD

A. Location

Site #9 is located on the Corbin - Wickes Road approximately 1.2 miles southwest of Corbin. This northern Jefferson County site is located in gently rolling terrain and consists of a series of reverse curves. Land in this lightly developed area is primarily used as pasture for livestock. Some isolated residential development has occurred in the area. The location of Site #9 and the traffic count data collected for the Corbin - Wickes Road are presented in Figure 9A.

B. Existing Conditions

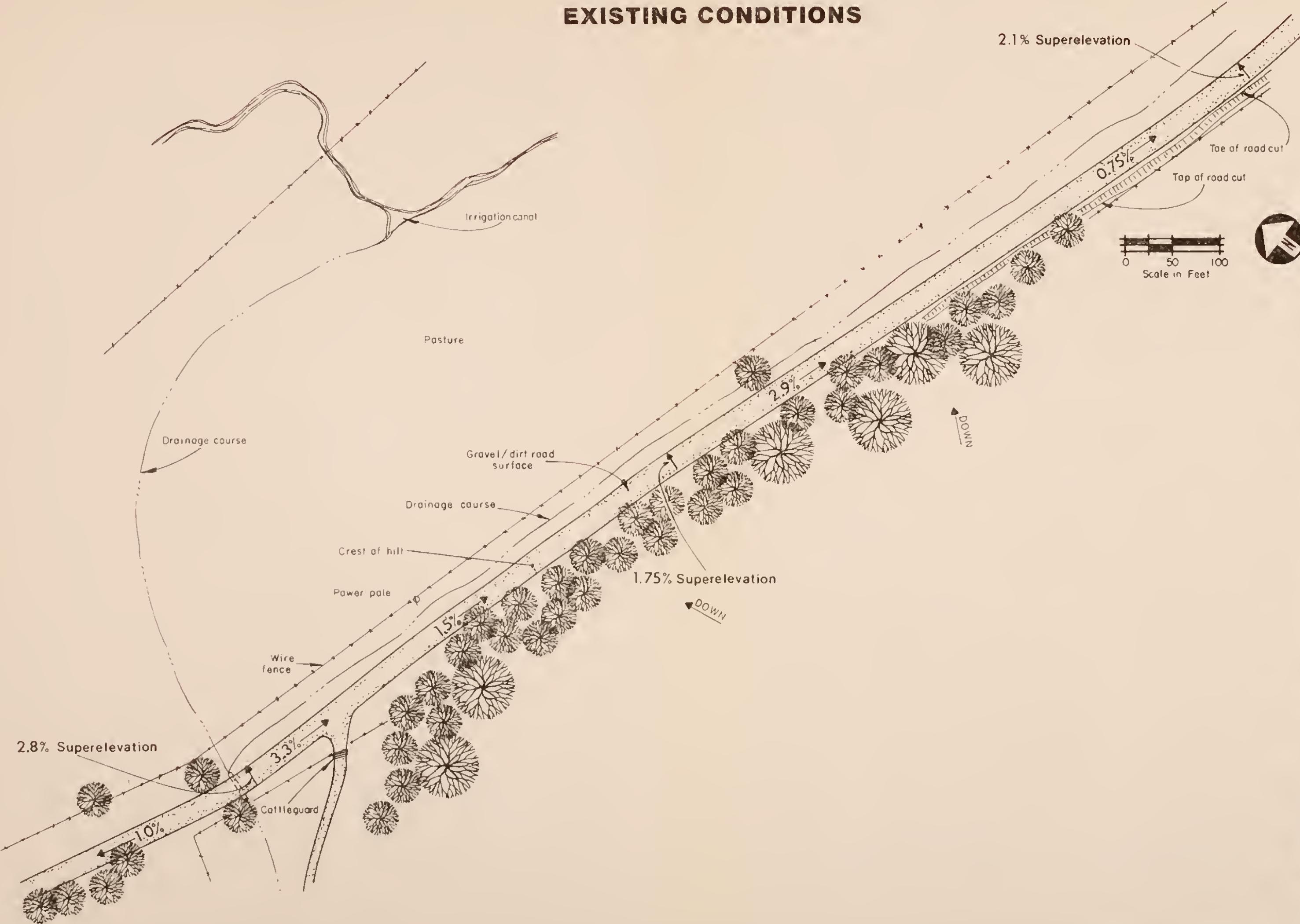
The Corbin - Wickes county road is a gravel-surfaced roadway that is typically 21 feet wide. Road grades within the site are relatively flat, ranging from 0.75 percent on the north approach to a maximum of 3.3 percent midway through the site. Superelevations within the north and south curves at the site are quite flat, averaging from 2 to 3 percent. The superelevation in the middle curve is not effective because the roadway slopes at about 2 percent toward the outside of the curve. This geometric condition tends to inhibit vehicle movement. The changes in road alignment and grade through this site limit sight distance to approximately 160 feet. Obstructions are generally more than ten feet from the edge of the roadway; however, steep areas exist adjacent to the roadway shoulder through much of the site. Currently, no signing exists within the site. The existing conditions at this site are depicted in Figure 9B and in Plate 9.

Traffic data for the roadway within Site #9 was collected by Robert Peccia & Associates during November, 1982. Counts of 24-hour traffic volumes were utilized to determine the average daily traffic for the site. Based on this data, the average daily traffic (ADT) for this section of the Corbin - Wickes Road was determined to be 86 vehicles.

C. Accident History

A total of five accidents were reported at this site during the four-year accident study period. Three of the five accidents resulted in injuries to a total of eight persons. No fatality accidents were reported at this site. Three accidents at the site were single-vehicle accidents in which vehicles left the roadway and rolled down steep areas adjacent to the road. The other accidents were two-vehicle collisions which included an angle collision and a head-on collision. Seven of the eight reported injuries resulted from these accidents. Four of the five accidents occurred at dusk or during nighttime hours. Nearly all of the reported accidents occurred during clear weather and dry road conditions. The major contributing circumstance to the acci-

EXISTING CONDITIONS

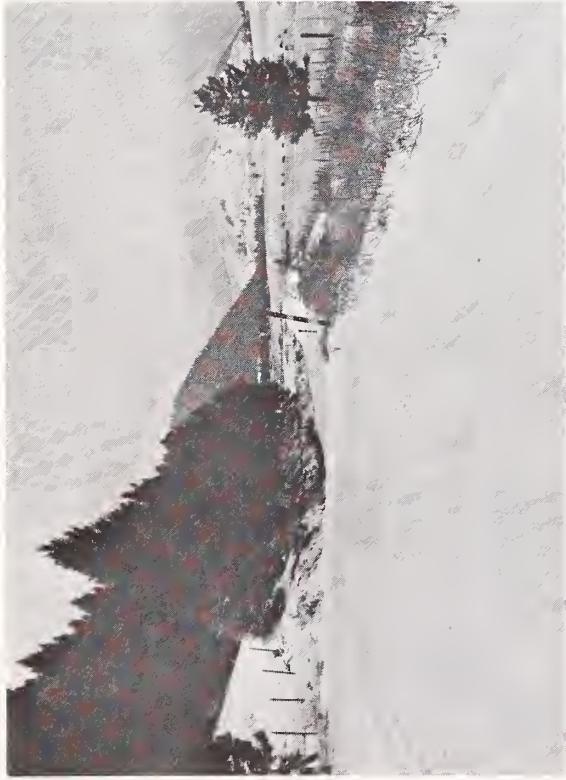


WICKES-CORBIN ROAD

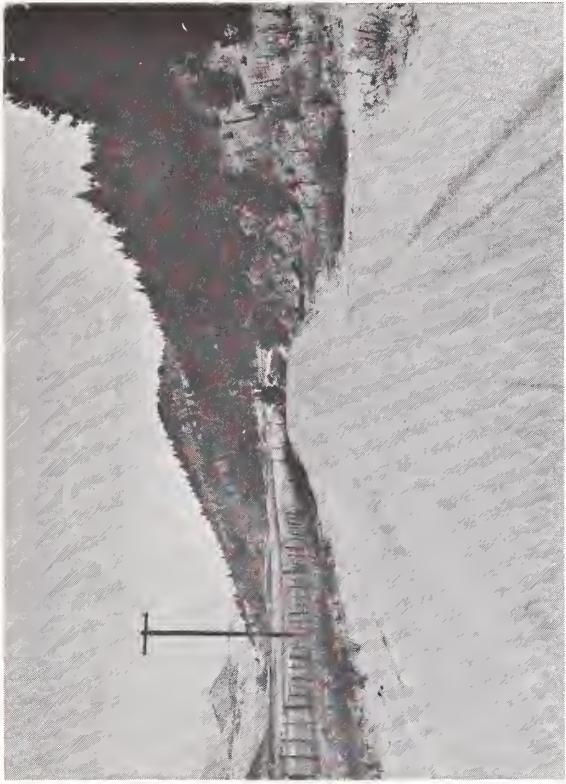
Site No. 9

Figure No.
9-B
Jefferson Co.

Existing Site Conditions



View of the roadway at the western end of the site looking toward Wicke's. Note culvert markers at the edge of the roadway.



The Corbin - Wicke's Road as viewed from the western end of Site 9.



Westward view along the Corbin - Wicke's Road. Note the steep areas adjacent to the right side of the roadway.



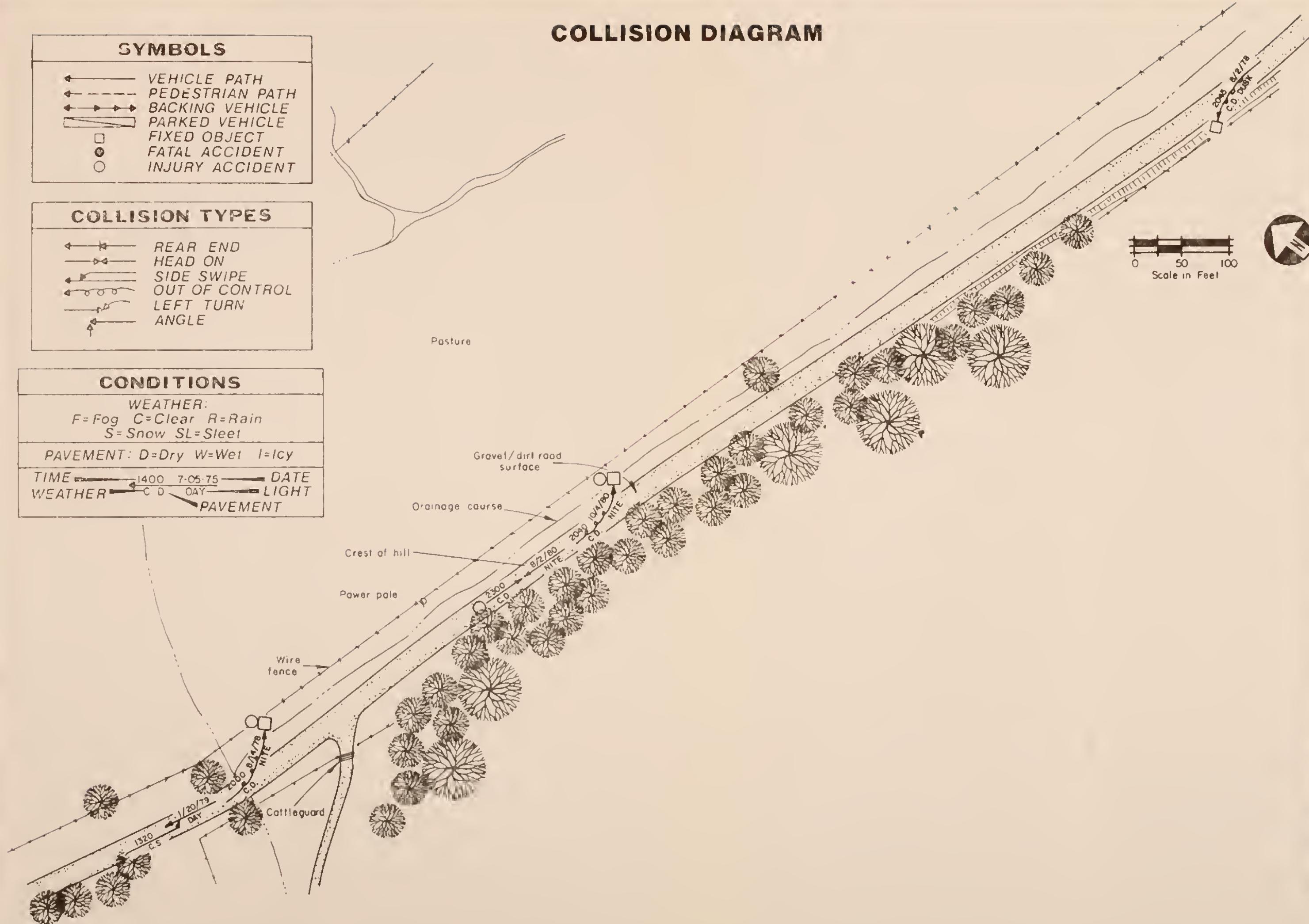
View of an area of restricted sight distance near the western edge of the site. Grade and alignment changes at this location limit sight distance to 150 feet.

SYMBOLS	
←	VEHICLE PATH
←—	PEDESTRIAN PATH
→→→	BACKING VEHICLE
—	PARKED VEHICLE
□	FIXED OBJECT
●	FATAL ACCIDENT
○	INJURY ACCIDENT

COLLISION TYPES	
←→	REAR END
—→	HEAD ON
→←	SIDE SWIPE
→→○○	OUT OF CONTROL
→○○	LEFT TURN
→○	ANGLE

CONDITIONS	
WEATHER:	
F=Fog	C=Clear
R=Rain	
S=Snow	SL=Sleet
PAVEMENT: D=Dry	W=Wet
I=ICY	
TIME	DATE
WEATHER	C D 7-05-75
	DAY
PAVEMENT	

COLLISION DIAGRAM



ACCIDENT DATA

Corbin - Wickes Road

SITE NUMBER 9

ACCIDENT PERIOD 1978 - 1981

**NUMBER OF ACCIDENTS
BY YEAR**

1978	1979	1980	1981
2	1	2	

NUMBER OF ACCIDENTS BY DAY OF WEEK

Sun.	Mon.	Tues.	Wed.	Thurs.	Fri.	Sat.
		1		1		3

NUMBER OF ACCIDENTS BY MONTH

Jan.	Feb.	March	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
1								3		1	

NUMBER OF ACCIDENTS BY TIME OF DAY

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
														1					3			1	

**NUMBER OF ACCIDENTS
BY LIGHT CONDITIONS**

Day-light	Dark	Dawn	Dusk
1	3		1

**NUMBER OF ACCIDENTS
BY ROAD CONDITIONS**

Dry	Wet	Snow	Ice	Other
4		1		

**NUMBER OF ACCIDENTS
BY WEATHER CONDITIONS**

Clear	Rain	Snow	Fog
5			

NUMBER OF ACCIDENTS BY ACCIDENT TYPE

Angle	Turn	Rear End	Fixed Obj.	Ped.	Animal	Side-swipe	Non-Col	Head-on	Backing
			3			1		1	

NUMBER OF ACCIDENTS BY POSSIBLE VIOLATION

No Ap. Violation	Drinking	Reckless Driving	Speed	Right-of Way	Improper Passing	Improper Backing	Improper Turning	Other
1			3	1				

NUMBER OF ACCIDENTS BY SEVERITY

	1978	1979	1980	1981
Injury	1		2	
Fatality				

Property Dam. Only	1978	1979	1980	1981
	1	1		

**NUMBER OF ACCIDENTS
ALCOHOL INVOLVED**

2

dents in this section of the Corbin - Wickes Road was listed as excessive speed for road conditions. Alcohol was involved in two of the five accidents at this site. The composite collision diagram for this site is depicted in Figure 9C.

The accident rate for this site is 39.8 accidents per million vehicles entering.

D. Recommendations

Site #9 is a gravel road with mild, long curves and minor grade changes. The accident records indicate that motorists have difficulty defining the road alignment, generally at night. The short-term improvements listed below concentrate on delineating the road and providing a better road cross section.

1. The use of reflectorized delineators at this site will greatly improve driver awareness of the slight alignment changes which seem to be at least partially responsible for the accidents at this location. It is recommended that nine reflectorized delineators (Design C, 4" x 4", silver, bi-directional) be installed along the north side of the road along the long sweeping curve in the center of this site. These reflectors should be spaced 100 feet apart. The curves at both ends of the site should be identified in a similar fashion. The curve at the east end of the site will require eight delineators spaced 100 feet apart and located on the south side of the road. The curve on the west end of the site is short and sharper than the other in the area, and should be delineated with six reflectors spaced 50 feet apart on the south side of the road. Two additional reflectors spaced 100 feet apart should be installed on the south side of the road to lead drivers into the curve at the west end of the site. These delineators will not only alert motorists of the roadway alignment, but will also clearly define the edge of the road so that vehicles can pass each other with greater safety.

2. The trees and brush adjacent to the south side of the road should be cut back. This vegetation limits the motorist's view of the road ahead and makes the road seem narrower than it actually is. These trees also tend to block the sunlight from the road surface during the winter, making this section of road almost always snow-packed or icy. It is recommended that the south side of the road be cleared of all vegetation for at least 20 feet from the edge of the roadway.

3. The cross grade in the long curve at the center of the site is sloping the wrong direction. In slight curves such as this one where the superelevation is incorrect, unsuspecting motorists will often drift to the outside of the curve and lose control of their vehicle on the edge of the road. It is recommended that this section of road be regraded to provide a 2 percent superelevation sloping toward the south side of the road.

IMPROVEMENT COST ESTIMATE

Quantity	Unit	Item Description	Unit Price	Total Price
25	ea	Install Reflectorized Delin-eators (Design C, 4" x 4", silver, bi-directional)	\$18	\$450
-	Lump Sum	Cut Trees and Brush	-	500
-	Lump Sum	Reshape Superelevation	-	<u>500</u>
Total Cost:				\$1,450

Benefit/Cost Ratio: 2.3

Long-Term Improvements

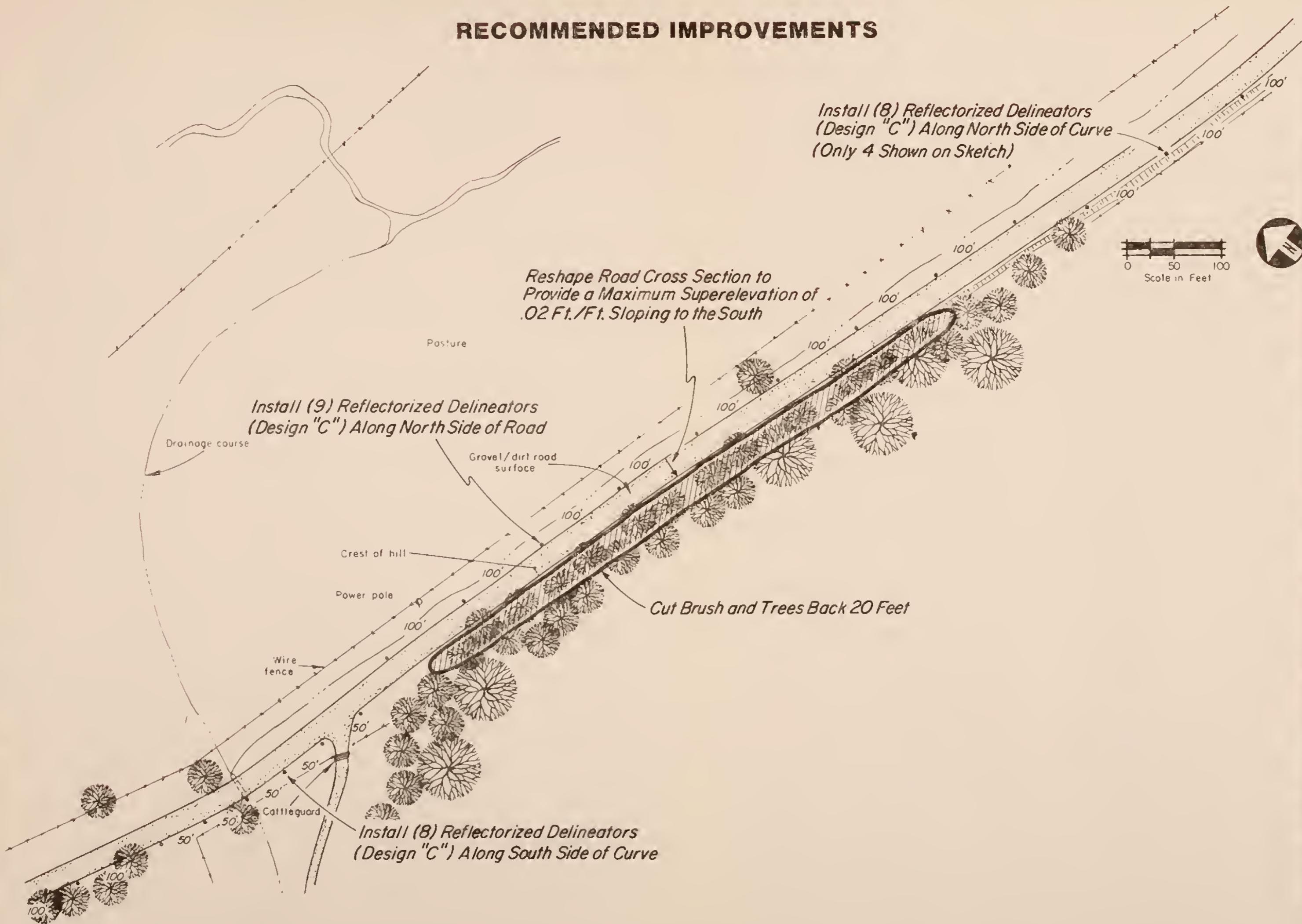
The short-term improvements recommended for this site adequately address the problems at this location; therefore, no long-term improvements are recommended.

RECOMMENDED IMPROVEMENTS

WICKES • CORBIN ROAD

g o e + o

Figure No. 9.D



DETERMINATION OF HAZARD INDEX

Site Number 9 Date December, 1982

Site Description Corbin - Wickes Road

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	<u>1.25</u> acc/yr	<u>30</u>	x 0.164	= <u>4.92</u>
Accident Rate	<u>39.8</u> acc/MVE	<u>100</u>	x 0.225	= <u>22.50</u>
Accident Severity	<u>15,280</u> dollars	<u>76</u>	x 0.191	= <u>14.52</u>
Volume/Capacity Ratio	<u>.05</u>	<u>17</u>	x 0.082	= <u>1.39</u>
Sight Distance Ratio	<u>.52</u> (wt. avg.)	<u>98</u>	x 0.074	= <u>7.25</u>
Driver Expectancy	<u>2.0</u> (wt. avg.)	<u>33</u>	x 0.149	= <u>4.92</u>
Information System Deficiencies	<u>4.5</u> (wt. avg.)	<u>75</u>	x 0.115	= <u>8.63</u>

Hazard Index: 64.13

Cost of Recommended Improvements: \$1,450

Cost Factor: 82

Priority Index = Hazard Index x .75 + Cost Factor x .25

64.13 x .75 + 82 x .25 = 68.60

CHAPTER V

BIBLIOGRAPHY

BIBLIOGRAPHY

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CHAPTER VI

APPENDIX

DETERMINATION OF HAZARD INDEX

Site Number _____ Date _____

Site Description _____

Indicator	Data Value	Indicator Value	Weight	Partial H.I.'s
Number of Accidents	_____ acc/yr	_____	x 0.164 =	_____
Accident Rate	_____ acc/MVE	_____	x 0.225 =	_____
Accident Severity	_____ dollars	_____	x 0.191 =	_____
Volume/Capacity Ratio	_____	_____	x 0.082 =	_____
Sight Distance Ratio	_____ (wt. avg.)	_____	x 0.074 =	_____
Driver Expectancy	_____ (wt. avg.)	_____	x 0.149 =	_____
Information System Deficiencies	_____ (wt. avg.)	_____	x 0.115 =	_____

Hazard Index: _____

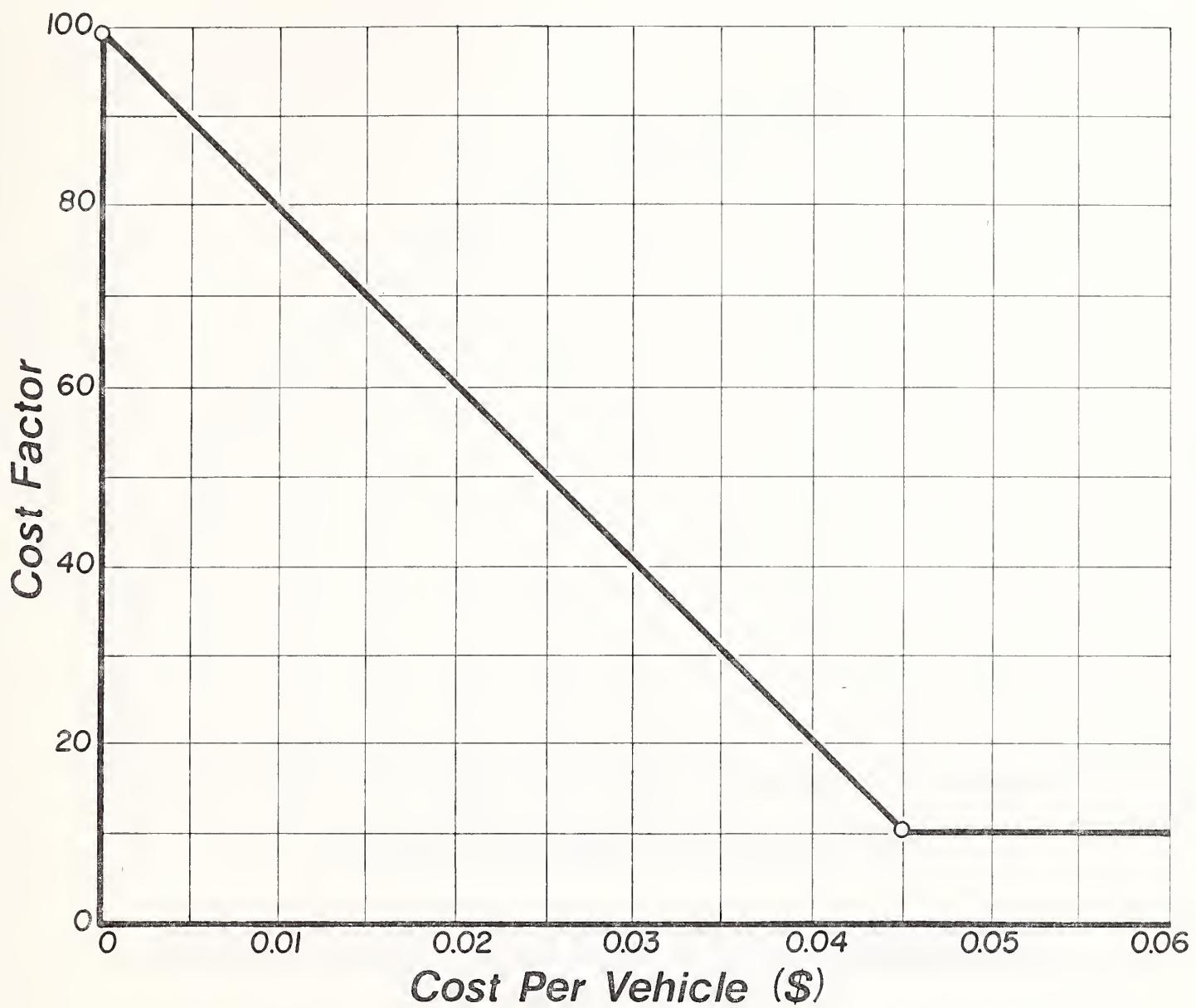
Cost of Recommended Improvements: _____

Cost Factor: _____

Priority Index = Hazard Index x .75 + Cost Factor x .25

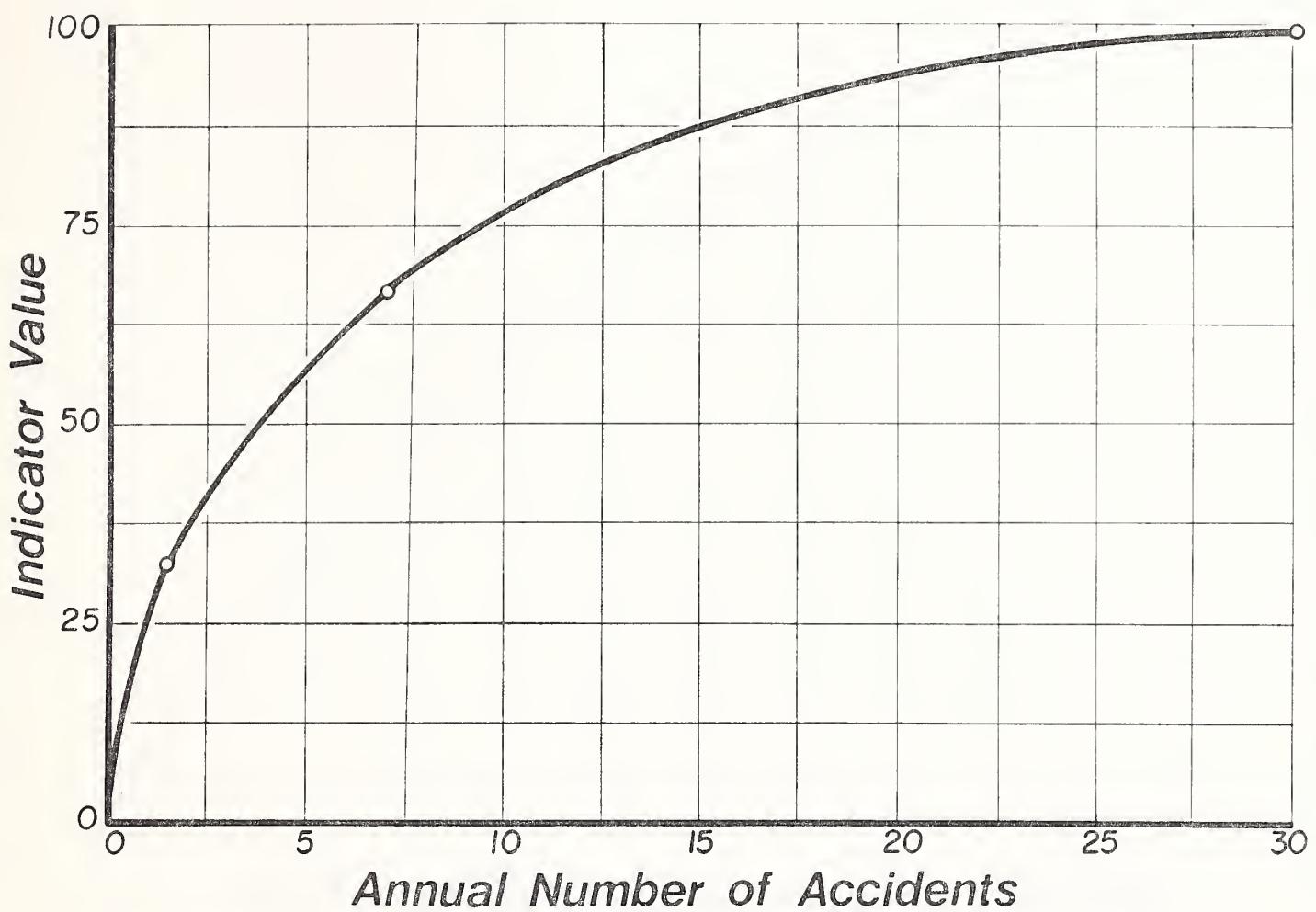
_____ x .75 + _____ x .25 = _____

FIGURE A1



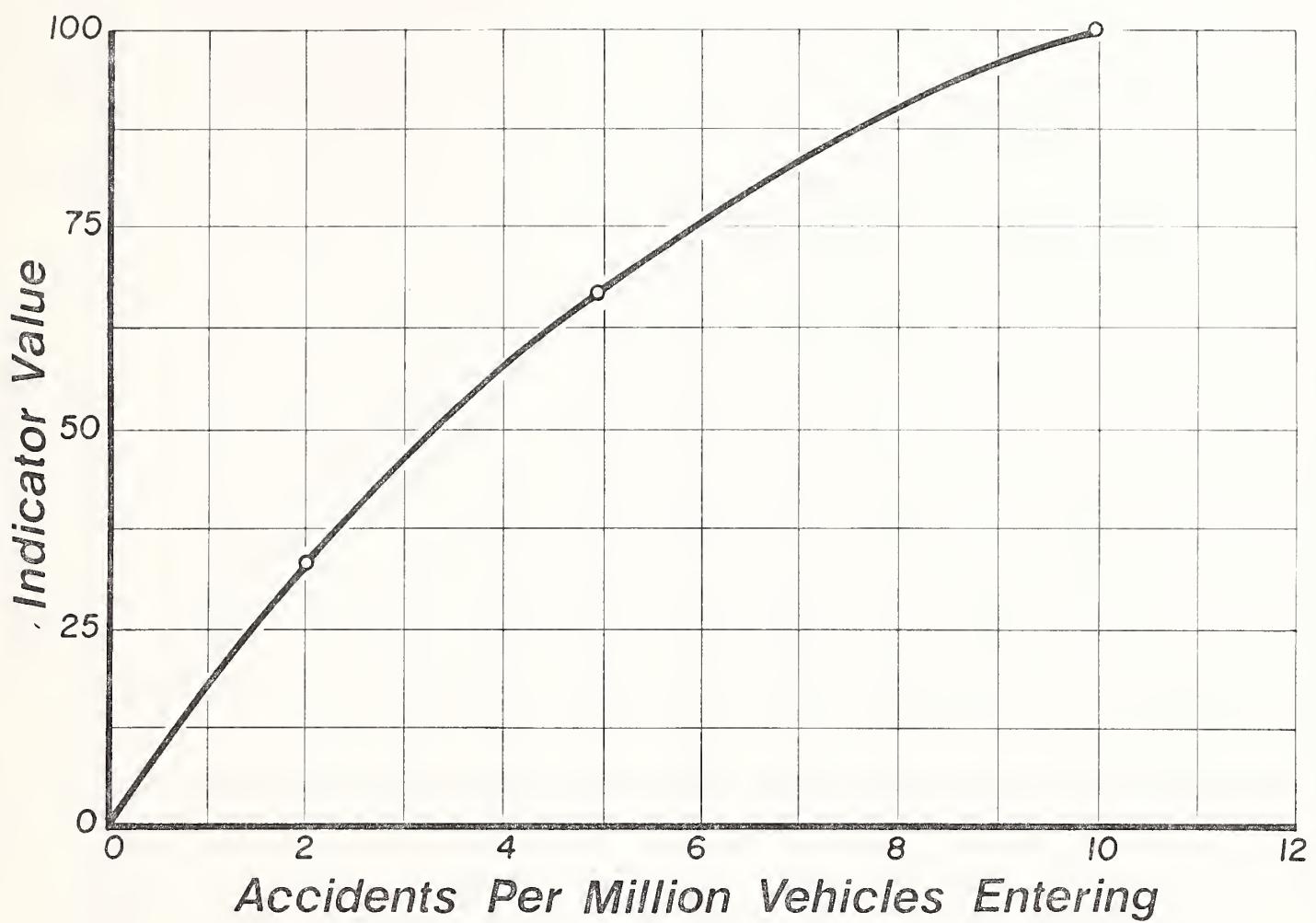
FORM FOR DETERMINATION OF COST FACTOR

FIGURE A 2



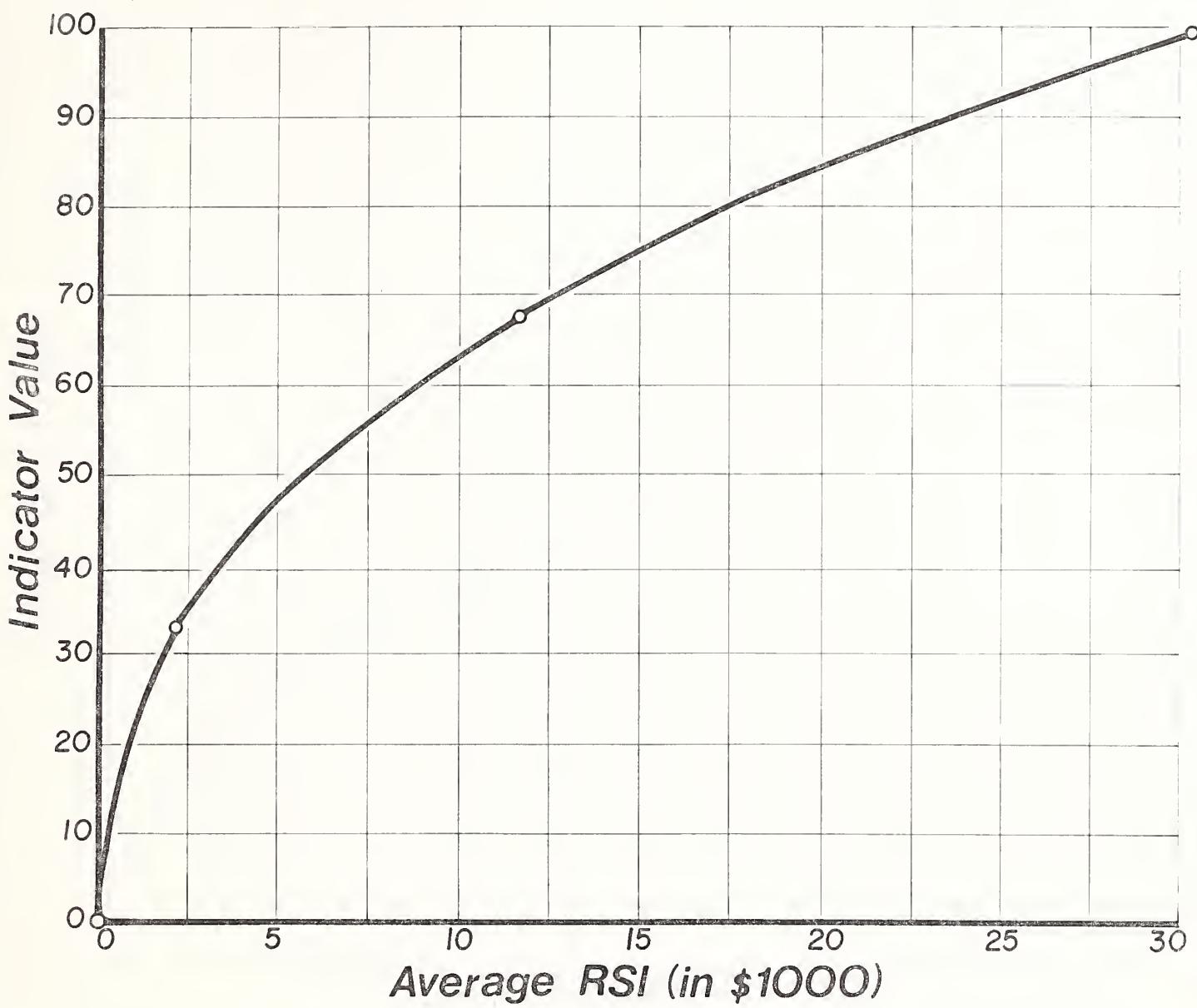
INDICATOR VALUES FOR NUMBER OF ACCIDENTS

FIGURE A3



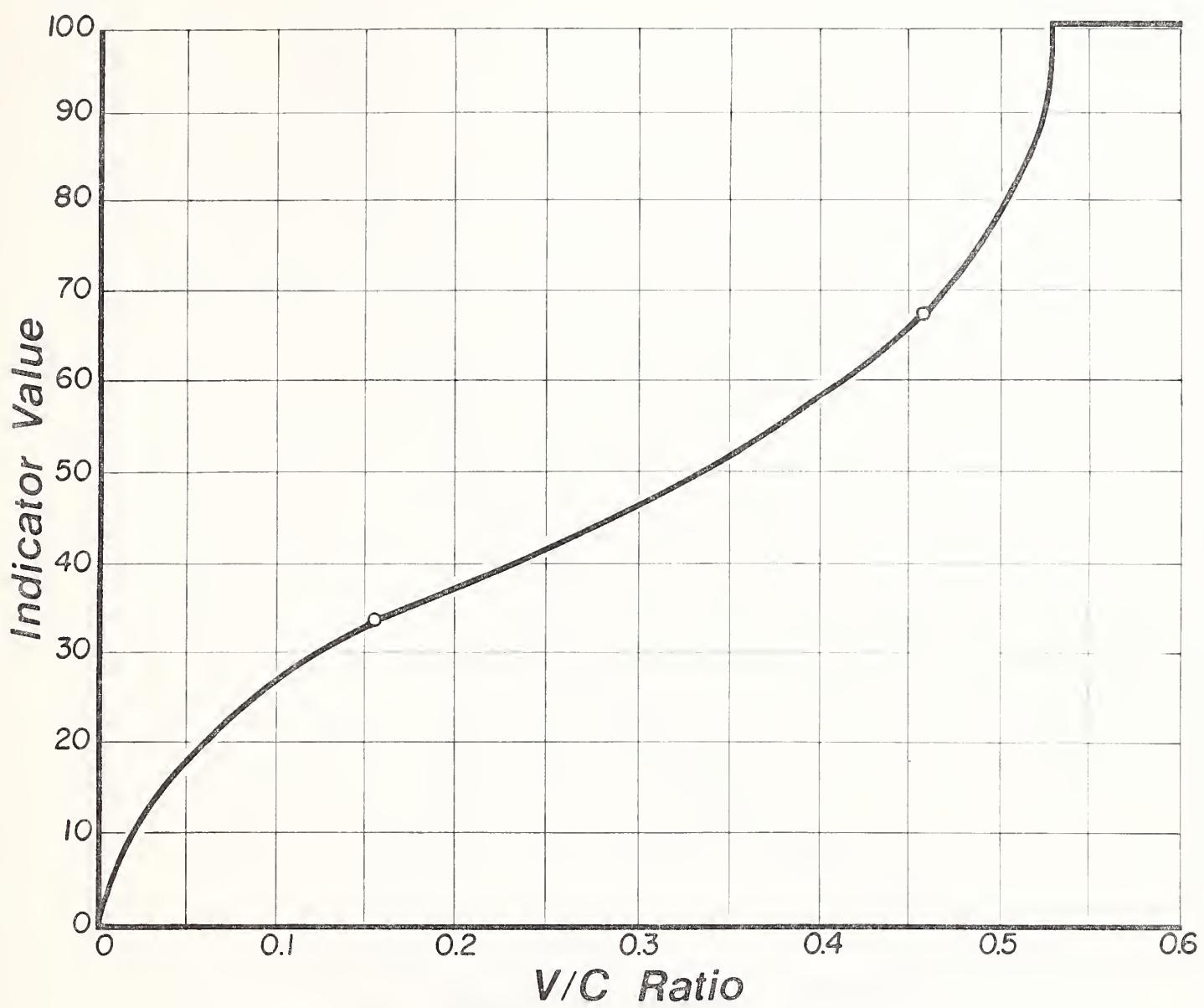
INDICATOR VALUES FOR ACCIDENT RATE

FIGURE A4



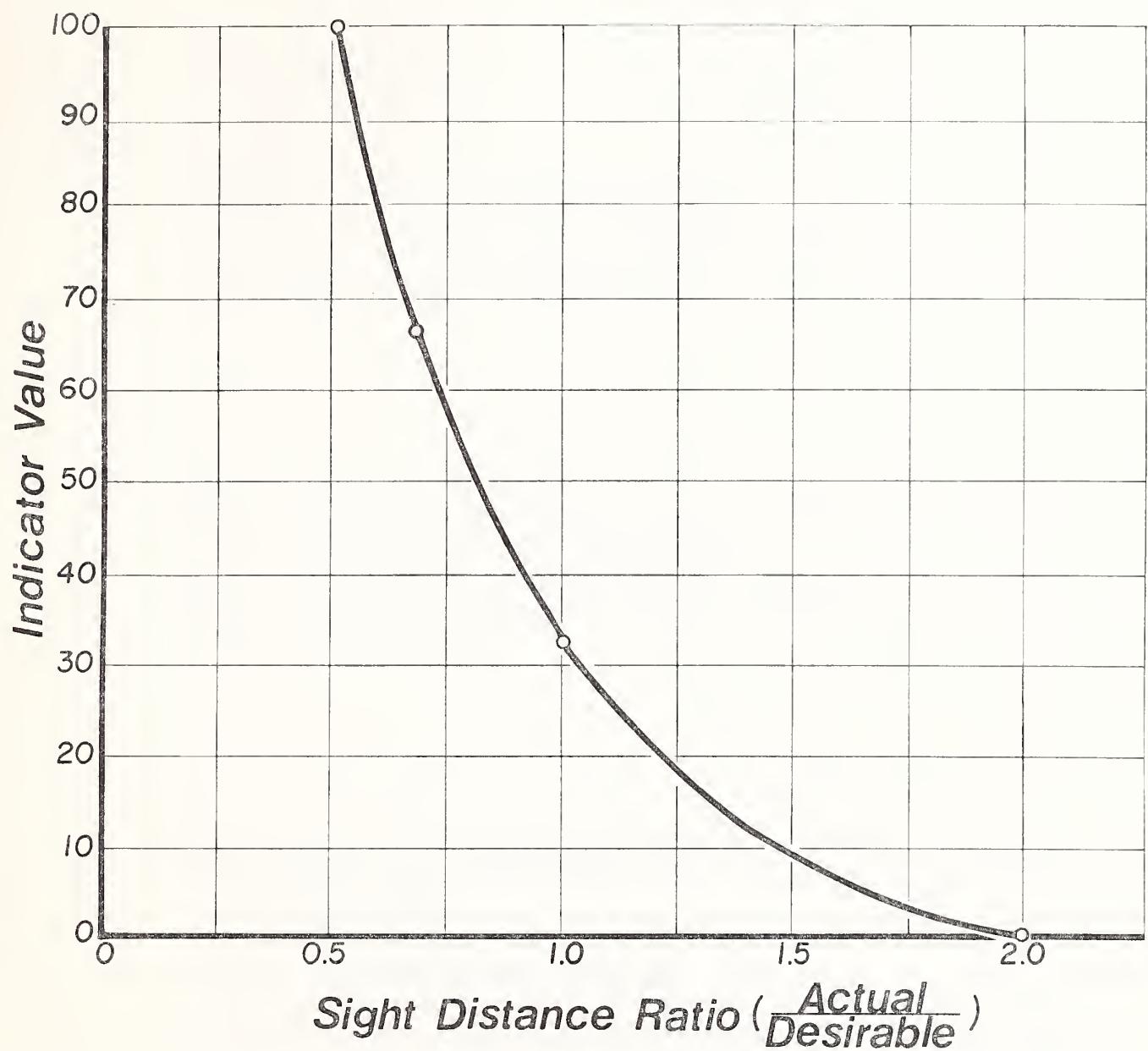
INDICATOR VALUE FOR ACCIDENT SEVERITY

FIGURE A5



**INDICATOR VALUES FOR
V/C RATIO**

FIGURE A6



INDICATOR VALUES FOR SIGHT DISTANCE

FIGURE A7

DRIVER EXPECTANCY PROBLEMS RATING FORM

Ratings

0 Nothing unexpected or unusual at this location.
Actions required (if any) entirely consistent with driving strategy on approach. Standard geometry, with pathway(s) for intended movement(s) clearly evident. No interferences by other traffic likely.

1

2

3 Situation somewhat unexpected.
Driver must be alert, but should be able to respond adequately at "last minute" to most combinations of adverse circumstances.
Some initial confusion on intended path(s) or movement(s).
Interference from other traffic may create some degree of confusion or uncertainty for average driver.

4

5

6 Very unusual situation; will surprise many unfamiliar drivers.
Driver required to make major changes in driving tactics from those employed over past few miles.
At least a "near accident" almost expected if driver is even moderately inattentive; evasive actions likely to be required.
Intended pathway(s) confusing under fairly normal traffic or lighting conditions.
Other traffic, or lack of it, aggravates situation and misleads driver or deprives him of important cues.

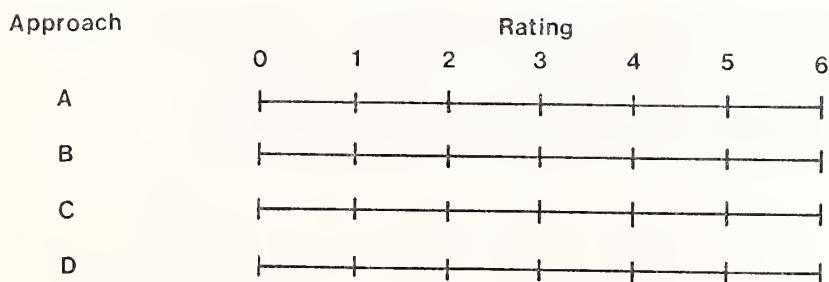
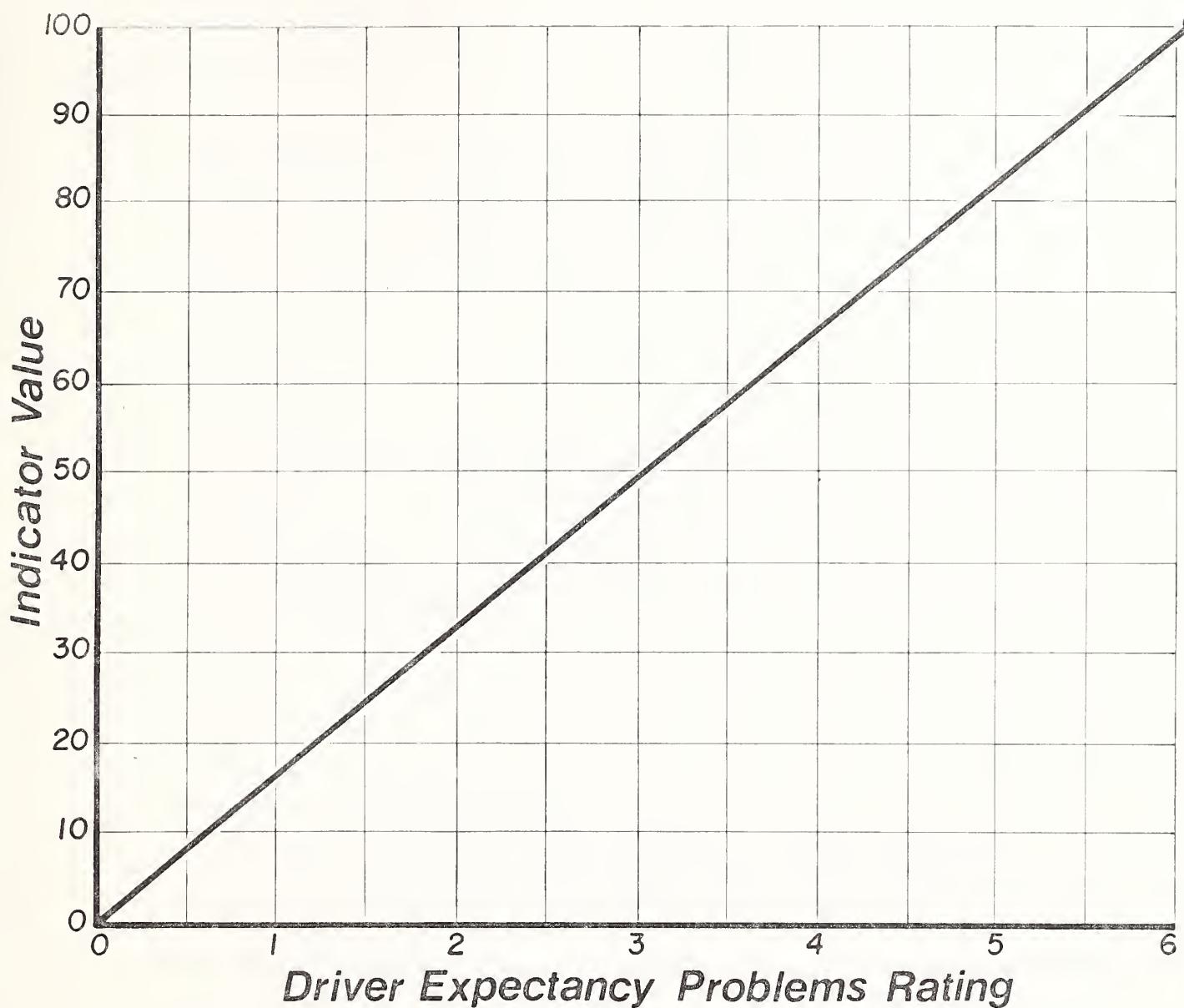


FIGURE A8



INDICATOR VALUES FOR DRIVER EXPECTANCY

FIGURE A9

INFORMATION SYSTEM DEFICIENCIES RATING FORM

Ratings

0 Information for required decisions complete and unambiguous.
Signs, markings, delineation in good repair, clean, highly visible.
"Positive guidance" leads driver to appropriate path; makes "error" difficult.
Approach speeds of most drivers are appropriate.
Light decision load; easy and obvious.

1

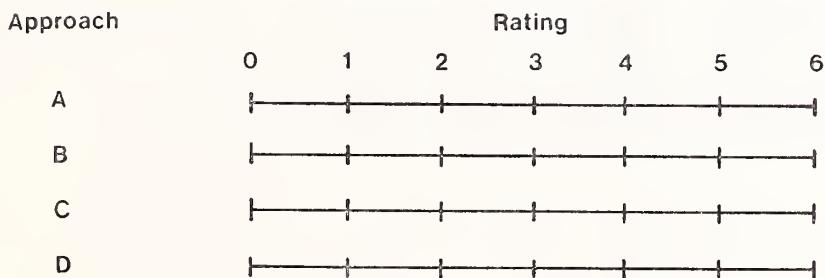
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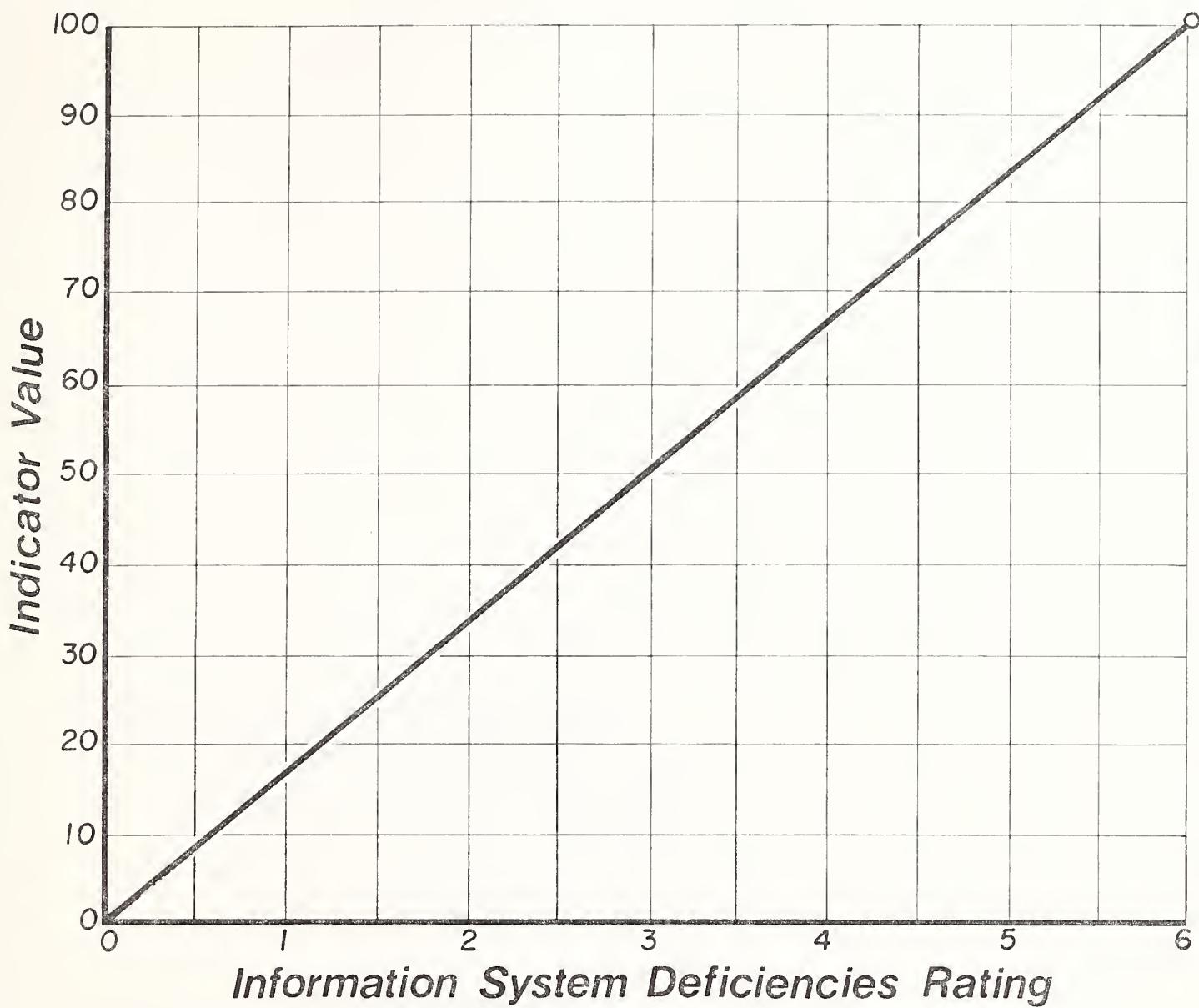
3 Some information lacking or somewhat misleading.
Signs should be moved or augmented for better visibility or to provide more decision time.
Visibility of signs, marking, and delineation barely adequate.
Medium decision load; average driver will be able to handle situation, but may be a little uncomfortable.

4

5

6 Important information missing.
Complete new "information system" needed — design and installation.
Present signs and markings in very poor condition; need replacement.
Speed limit and/or advisory speed needed; either missing or totally inappropriate at present.
"Positive guidance" on appropriate path lacking; a clutter of negative delineation only.
Heavy decision load; complete attention of average driver required; a "tense" situation at best.





INDICATOR VALUES FOR INFORMATION SYSTEM DEFICIENCIES

FIGURE A11

BENEFIT / COST RATIO WORKSHEET

Location: _____ Milepost: _____

Improvement Description: _____

Estimated Service Life _____ Years = T

Compounded Interest Rate _____ % = R

Current 19 _____ ADT _____

Time Frame for Accident Data: From _____ To _____ = _____ Years

I. ANNUAL COST FOR THE IMPROVEMENT:

1. C = Capital Cost for Improvement \$ _____
2. K = Capital Recovery Factor = $K = \frac{R(1+R)^T}{(1+R)^T - 1}$ = _____
3. M = Change in Annual Maintenance or Operation Cost \$ _____
4. Annual Cost = (C - K) + M = \$ _____

II. ANNUAL BENEFIT OF THE IMPROVEMENT:

1. ADT_a = Average Daily Traffic After Improvement: _____
2. ADT_b = Average Daily Traffic Before Improvement: _____
3. I/F = Ratio of Injuries to Fatalities for the Class of Highway Involved: _____
4. $Q = * + (I/F)** = \frac{1}{1+I/F} = \frac{*}{1+I/F} = \frac{**}{1+I/F} = \frac{* + (I/F)**}{1+I/F} = \frac{* + (I/F)*}{1+I/F} = \frac{* + (I/F)*}{1+I/F}$ = _____

* Current cost of a fatal accident from National Safety Council memo No. 113 =
\$ _____

** Cost of an injury accident = \$ _____

5. Afi = Annual average number of fatal accidents and injury accidents combined at the location which will be affected by the improvement =

$\frac{\text{No.}}{\text{Years}} = \frac{\text{_____}}{\text{_____}} = \frac{\text{_____}}{\text{_____}}$

6. $Apd = \text{Annual Average Number of Property Damage Accidents at the Location} =$

$$\frac{\text{No.}}{\text{Years}} = \text{_____} = \text{_____}$$

7. $Pfi = \text{Expected Percentage Reduction of Fatal and Injury Accidents by Improvement} =$

$$\text{_____ \%}$$

8. $Ppd = \text{Expected Percentage Reduction of Property Damage Accidents by Improvement} =$

$$\text{_____ \%}$$

a. $P_1 = \text{Largest percentage reduction in accident of any one of the improvements.}$

b. $P_2 = \text{Second largest percentage reduction in accidents of any of the improvements.}$

c. $P_3 = \text{Third largest percentage reduction in accidents of any of the improvements.}$

d. $Pfi \text{ and } Ppd \text{ for location where more than one improvement will be used in combination} = P_1 + \left(\frac{100 - P_1}{100} \right) P_2 + \left(\frac{100 - P_1}{100} \right) \left(\frac{100 - P_2}{100} \right) P_3 + \dots$

9. $\text{Annual Benefit} = \frac{ADT_a}{ADT_b} [Q(Afi) pfi + *** (Apd) Ppd] = \text{_____}$

*** Cost of a property damage accident = \$_____

III. $\text{BENEFIT / COST RATIO} = \frac{\text{Annual Benefit}}{\text{Annual Cost}} = \text{_____} = \text{_____}$

RELATIVE SEVERITY INDEX
BY TYPE OF ACCIDENT *

<u>Multi-Vehicle, At Intersection</u>	<u>Urban</u>	<u>Rural</u>
Entering at angle	\$4,300	\$14,400
From same direction – both going straight	2,800	5,100
From same direction – one turn, one straight	2,500	5,100
From same direction – one stopped	3,800	5,200
From same direction – all others	2,000	6,300
From opposite direction – both going straight	4,000	20,000
From opposite direction – one left turn, one straight	4,400	15,400
From opposite direction – all others	2,700	3,800
Not stated	3,800	5,200
<u>Multi-Vehicle, Non-Intersection</u>		
Going opposite direction – both moving	\$4,400	\$19,600
Going same direction – both moving	2,900	8,100
One car parked	1,600	2,400
One car stopped in traffic	4,200	6,800
One car entering parked position	1,900	2,300
One car leaving parked position	1,200	2,700
One car entering alley or driveway	3,400	6,000
One car leaving alley or driveway	2,000	4,400
All others	1,700	7,600
Not stated	3,400	6,000
<u>Motor Vehicle with Pedestrian, At Intersection</u> <u>and Non-Intersection</u>		
Vehicle going straight	\$20,000	\$49,000
Vehicle turning right	13,600	11,200
Vehicle turning left	17,100	11,200
Vehicle backing	20,600	11,200
All others	14,500	11,200
Not stated	11,200	11,200

* FHWA-RD-77-87 "Identification of Hazardous Locations"

	<u>Urban</u>	<u>Rural</u>
<u>Single Vehicle, at Intersection</u>		
Collision with train	\$26,700	\$39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jacknifed	5,200	2,000
Collision with fixed object in road	5,500	7,000
Overturned in road	9,200	7,500
Left road	5,200	12,300
<u>Single Vehicle, Non-Intersection</u>		
Collision with train	\$26,700	\$39,100
Collision with bicycle	13,100	31,900
Injury in vehicle, jacknifed	5,200	2,000
Collision with fixed object in road	6,300	9,200
Overturned in road	10,000	9,400
Left road at curve	7,600	12,400
Left road on straight road	5,200	10,500
<u>Other One Motor Vehicle, At Intersection</u>		
<u>and Non-Intersection</u>		
Fell from moving vehicle	\$15,000	\$57,200
Collision with animal	4,800	1,800
Collision with other object	4,700	4,400
All others	5,200	2,000
Not stated	3,200	3,400

— TABLE A1 (Continued) —

